



# Virtualization: Evolution to Revolution

Landmark technology decouples hardware from software to cut cost and complexity.

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## Executive Summary

Computers have become ubiquitous in the business world over the last few decades. As such technology became more widely available and its price more affordable, a wave of device proliferation and underuse has occurred. This uncontrolled sprawl has led to increased support staff, burgeoning data centers and a costly need for more power and cooling. All of these factors reduce Return on Investment (ROI) and increase Total Cost of Ownership (TCO).

Virtualization provides a valuable solution to these IT challenges by minimizing IT complexity and lowering operating costs. A company that properly employs virtualization gains greater responsiveness and flexibility while promoting more effective use of IT resources. Virtualization also plays a role in assisting security and disaster-recovery efforts. While most commonly applied to servers, virtualization is quickly finding its way to other facets of IT.

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# Why Virtualization Makes Sense

Highly dynamic in nature, IT now forms a critical part of every organization. Innovation in hardware and software technology often helps facilitate the tactics required to meet business strategy deemed essential to success. The adoption of virtualization is a current, prominent example of how such innovation is occurring.

With the explosive growth of data center use in the 1990s, challenges emerged. The cost to support a sprawling physical infrastructure increased dramatically. These increases applied not only to hardware, power and cooling, but to management and maintenance as well.

Underutilization of servers, for example, became a problem. International Data Corporation (IDC) has estimated, in fact, that servers still see average utilization rates of as low as 15 percent of their total capacity. In addition, such systems often lacked sufficient disaster-recovery or failover protection, while security frequently remained inadequate.

By 2002, many organizations rightly began to view this setup as untenable. Enterprising IT managers began to see the potential for applying virtualization technology not only to their servers but also across other areas of the network.

Virtualization can cross many IT boundaries to create a wide array of operational efficiencies. Here we will focus on:

- Server Virtualization
- Client Virtualization

## Virtualization 101

In its most basic sense, virtualization removes physical barriers and decouples one technology from another, thereby removing intricate dependencies.

In server virtualization, virtualized hardware is presented to the operating system simply by decoupling physical server hardware from both the operating system and application software.

Client virtualization differs from server virtualization in key respects, but the premise remains the same. It ensures that the endpoint device (i.e., desktop, thin client, etc.) has some virtualization characteristic, through isolation, deduplication, streaming, encapsulation or hardware independence.

## Less Cost; Less Complexity

IT managers have embraced virtualization principally because it reduces costs and complexity. With areas such as server virtualization reaching maturity, IT managers have grown eager to put virtualization benefits to work more broadly across their networks and throughout their organizations.

Different kinds of virtualization can be used in different situations in order to apply resources where they're needed. The key for businesses will involve drawing the greatest advantage from a virtual environment in terms of management and automation.

This white paper aims to help you achieve precisely that end by concentrating on areas that can yield marked improvement via a virtualized infrastructure. It provides information that will assist in making educated decisions as you move forward with virtualization initiatives.

## Above the Virtualization Din

The virtualization buzz is loud and getting louder. It's no wonder as IT budgets slim, IT resources shrink and security becomes salient. In addition to being able to assist in all of these areas and more, virtualization can greatly enhance a firm's agility.

The technology offers a paradigm shift in the way IT organizations look at computing resources. Currently, the focus is on managing individual machines. As virtualization makes management easier, IT can focus on the services the technology can provide.

This allows IT organizations to operate more strategically, keeping information aligned with the business goals of the organization. The objective is to gain competitive advantage, bolster productivity and enable IT to operate more effectively.

# Server Virtualization: Solutions Overview

The most widely adopted of the available technologies, server virtualization houses multiple application servers on fewer physical servers. This strategy reduces the number of physical servers in the data center while increasing their utilization. Unquestionably, the technology offers solutions to many of the challenges that IT departments face today, most importantly maximizing budget dollars.

## IT Challenges

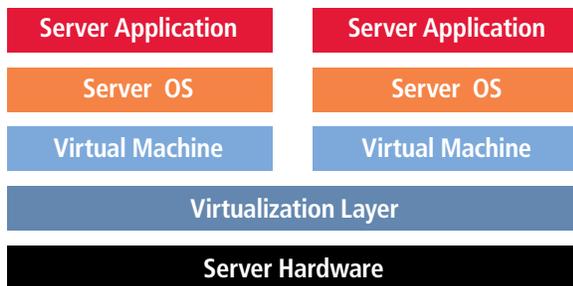
The IT industry has dramatically evolved over the last decade. Organizations have gained access to greater technological capabilities through inexpensive x86 server systems as well as the applications and operating systems that run on this platform.

However, adoption rates increased so rapidly that many businesses today now face a myriad of difficulties, each of which virtualization can potentially remedy. These issues include:

- Increased Total Cost of Ownership (TCO)
- Server sprawl
- Low server utilization
- Complex server-storage migration
- Inefficient server deployment
- High-availability complexity
- Disaster-recovery complexity
- Power and cooling inefficiency

## Server Virtualization 101

As noted earlier, server virtualization technologies enable the separation of the operating system and applications from the physical hardware through the presentation of virtualized hardware. This decoupling creates not only separation but also isolation from other operating systems. For example, Windows Server, Linux, NetWare, etc. can now run side by side on the same physical hardware. Previously, each operating system demanded its own physical server.



## Do the Math

### Server virtualization bolsters the bottom line.

Server virtualization can make an organization really see green — and we’re not talking about the technology’s impressive energy savings. Significant cost savings can be achieved by journeying into the virtual world.

A major hardware manufacturer compared the cost of maintaining an infrastructure of 20 physical servers with the cost required to consolidate the same environment with three servers running 20 virtual machines.

The company found that over a three-year period, a firm deploying a completely physical environment would have to spend an average of \$57,640 on new servers, plus \$8,000 in provisioning costs, and around \$48,000 in power and cooling charges.

Conversely, an organization that consolidated through virtualization would spend \$25,566 on the new servers, \$1,500 on virtualization software, \$800 on provisioning, and \$20,000 on power and cooling over the same three-year cycle.

The end result? The firm that chose server virtualization would pocket \$65,474 over three years. It is easy being green.

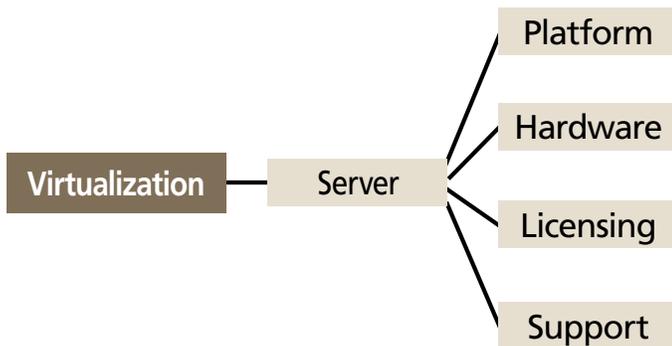
## Solution Benefits

Cost of ownership acts as a major driver behind the adoption of server virtualization. According to a recent IDC survey, respondents not only validated a strong trend toward virtualization, but moreover, 62 percent cited lower TCO as a key benefit to adopt the technology. The most common benefits realized include:

- Reduced cost
  - o Server/storage hardware
  - o Rack space
  - o Power/cooling
  - o Network, Storage Area Network (SAN), Keyboard/Video/Mouse (KVM) ports
  - o Increased productivity
- IT responsiveness
  - o Increased system utilization
  - o Easier testing and development
  - o Simplified migrations
  - o Predictable High Availability (HA) and Disaster Recovery (DR)

# Server Virtualization: Solutions Components

A server virtualization solution may contain a number of components depending on your business requirements. The following diagram groups the most common components to consider when planning and designing a complete server virtualization solution. This section will briefly discuss each component.



## Platform

Two basic server virtualization platforms exist today:

**HOSTED VIRTUALIZATION** — requires a general purpose operating system, such as Windows Server or Red Hat Enterprise Linux, underneath the virtualization layer. Examples of such platforms include Microsoft Virtual Server and VMware Server.

**HYPERVERSOR-BASED VIRTUALIZATION** — the most popular virtualization platform runs without the use of any general-purpose operating system. Examples include VMware ESX Server, Citrix XenServer and Microsoft Hyper-V.

## Hardware

Choosing the right hardware for your virtualization platform can be a project in itself. Let's start with server hardware.

Though existing servers could potentially be used, most businesses purchase new servers due to the increased processing and memory capacity as well as the reduced power consumption. When comparing servers, firms choose between rack or blade, 2-way or high-end 16-way servers as well as Intel or AMD processors.

Since the majority of server virtualization solutions are deployed using shared storage, a number of variables require consideration before making a storage platform choice. First, choosing a storage protocol becomes important since not all storage vendors support all currently

available protocols (e.g., Fibre Channel, iSCSI, NFS, etc.). The drive technology demands consideration for the same reason. Today's options include SATA, SAS drives and interconnect technology, which includes SAS and Fibre Channel.

Finally, it may prove important to evaluate the network hardware during your virtualization design, since certain features now require Gigabit connectivity. Don't forget to consider new technologies to reduce the number of Ethernet connections per server, including, 10Gb and Fibre Channel over Ethernet (FCoE).

## Licensing

Licensing probably remains the most misunderstood component of both server and client virtualization technologies. Each virtualization platform licenses its software very differently, so each option requires independent evaluation.

Each operating system vendor also has its own licensing rules and provisions for virtualization that need investigation. Microsoft, for example, allows businesses licensed for Windows Server Datacenter Edition to run an unlimited number of Windows Server virtual machines. The licensing also removes restrictions on their migration via VMware VMotion, Citrix XenMotion or Microsoft Quick/Live Migration between physical hosts.

Applications usually provide the most complex licensing issues because every vendor defines specific provisions and restrictions as to how each of its applications may be used. For example, Microsoft allows virtualization of the newest Exchange and SQL Server versions along with migration on demand. However, it doesn't allow previous versions to move on demand unless each physical host has a server license assigned to it.

## Support

When developing your virtualization solution, your plan should include a means of support for every component working together.

Virtualization solution providers usually require the purchase of some level of support with every license. Options usually include four-hour or faster incident response.

Keep in mind that this support doesn't include troubleshooting of the operating system or those applications that run inside a virtual machine. At a minimum, operating system and application server support should thus be obtained, in addition to determining that the software vendor actually supports virtualization.

# Client Virtualization: Solutions Overview

The proliferation of desktops, notebook PCs and other client devices has organizations struggling to find ways to manage and maintain these devices. At the same time, they must reduce costs and increase end-user productivity.

Wide adoption of server virtualization in the data center has led to renewed interest in client virtualization (also known as Virtual Desktop Infrastructure or VDI). However, unlike server virtualization, a number of technologies comprise the client virtualization stack.

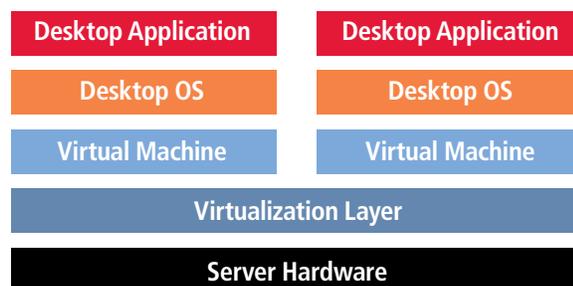
Overall, client virtualization can greatly simplify and lower IT management and administration costs. It can also improve and ensure compliance and security, improve uptime and simplify IT desktop provisioning, administration and service.

## Client Virtualization 101

Client virtualization exists in a number of technologies. However, the basic premise remains quite similar to server virtualization: decouple hardware and software component isolation in order to allow multiple desktops to run on one physical piece of server hardware.

However, in addition to isolation, it also achieves a measure of security since it eliminates the storage of data at the end-user device. Instead, it securely locates all data in the data center, thereby enabling both high availability and recovery capabilities.

The following diagram depicts the most common form of client virtualization. It differs from server virtualization only when the solution includes application virtualization, server-based computing (Terminal Services) and operating system streaming technologies.



### Client Virtualization Driver: Manageability

Client virtualization is a server-centric computing model. While it borrows from the classic thin-client model, it offers IT the ability to host and centrally manage Virtual Machines (VMs) while providing end users a full desktop experience.

According to the experts, consolidation was the immediate driver for server virtualization. As for client virtualization, it's manageability.

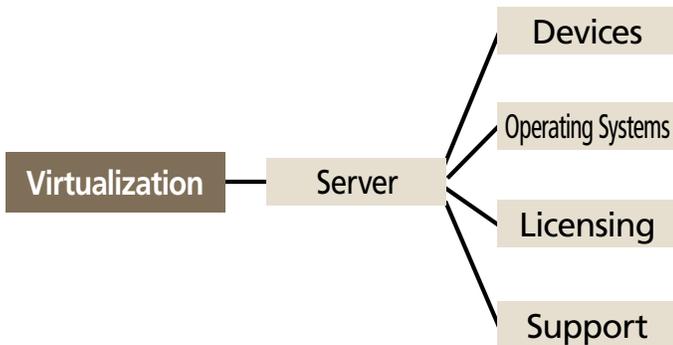
## Solution Benefits

Client virtualization, depending on the type of technology implemented, can result in a variety of benefits, including:

- Reduced management, maintenance and support costs
  - o Eliminate moving parts with thin clients
  - o Update device operating systems in minutes
  - o Control virus and malware outbreaks
  - o Roll back to previous versions quickly
  - o Create pooled and unique operating system images for different user groups
  - o Centralize control of all desktop operating systems and applications
  - o Reduce power and cooling requirements (if thin clients and Energy Star monitors are used in the solution)
- Increased responsiveness
  - o Allow rapid provisioning of operating systems and applications
  - o Reduce time to fix and troubleshoot technical issues
- Increased security and compliance
  - o Control OS and application patch updates
  - o Reduce device theft
  - o Increase data and remote access security

# Client Virtualization: Solution Components

As noted in the previous section, a number of components or technologies make up a client virtualization solution. Therefore, multiple components frequently combine to achieve the requirements that satisfy the organization's needs. This section briefly covers each of the most common components.



## Devices

When building a client virtualization solution, an important factor is the end-user experience. Start by analyzing your audience and how they will be using the client devices.

For example, consider your end users not only in terms of what devices they will employ —such as notebook PCs, desktops, tablet PCs and mobile devices — but also in light of the locations from which they will connect. Your analysis should likewise account for the types and numbers of displays users need and connections to peripherals, such as printers. Additionally, evaluate the required bandwidth.

Finally, determine which users require stringent security such as smart-card readers, biometric scanners, two-factor authentication tokens, etc. Identifying device types and user needs well ahead of implementing a client virtualization solution can eliminate some potential options that might otherwise be incorrectly chosen for your business.

## Operating Systems

There are many ways to present an operating system to your devices. In a hosted model, Windows can run on blade PCs, workstations in the data center or in virtual machines on a virtual platform.

Either way, a display protocol, such as Remote Desktop Protocol (RDP), Independent Computing Architecture (ICA) or Remote Graphics Software (RGS), generally delivers the operating system to the particular device for presentation to the user.

In both models, the processing actually occurs on blades or the hosted platform. For this reason, it doesn't matter whether your client devices are thin or thick, since connecting to the remote systems requires minimal client-side hardware.

Another possible solution involves hosting Windows images on a server, then streaming the operating system to existing desktops. This option works extremely well for firms looking to extend the lifecycle of existing desktops.

## Applications

Microsoft Terminal Services and Citrix XenApp technology, also known as server-based computing, hosts desktop applications on a Windows server and then delivers them to users via sessions (called Published Applications). This approach enables all the processing to occur at the server itself.

A newer technology available from a number of vendors, application streaming, focuses on isolation and streaming. Isolation refers to technology that installs the application locally on a desktop in a separate container, thereby isolating it from other applications.

In addition, installing software locally, either manually or with a software delivery solution, offers yet another option.

## Management

While determining what devices, operating systems and applications make up your client virtualization solution, you'll also need to think about a number of important components related to management.

The following list contains some of the components that should be evaluated end-to-end:

- Printing
- Security
- User Profiles
- Imaging (Operating System, Thin Client)
- Updating (Operating System Patches and Thin Client Firmware Updates)

# Virtualization: Things to Consider

Unquestionably, virtualization can significantly benefit many organizations. A few final considerations will prove important as you decide on the best approach to implementing this technology.

## Licensing

Besides the licensing costs of each virtualization solution, it's critical to understand the impact of operating systems and applications on the cost of virtualization.

For example, as noted earlier, Microsoft has special licensing provisions for Windows Server Enterprise and Datacenter Editions, starting with Windows Server 2003 R2. These provisions allow for multiple Windows instances to run on a server with a single license, which in most cases can save thousands of dollars. Similarly, Vista Enterprise Centralized Desktop (VECD), a subscription-based licensing model, allows the centralized hosting of Windows XP and Vista using virtual machine technologies.

## Support

As your organization begins to virtualize business applications, the importance of each software vendor's support stance becomes critical. Many vendors still don't support their applications in a virtual machine, so you'll need to evaluate your virtualization choices carefully.

## Application Architecture

In client virtualization solutions, understanding how each application works goes a long way to ensuring the success of the implementation. If using a server-based computing model, general business applications will perform well, as will applications that do not have graphics processor requirements.

Almost all of the available solutions have challenges with full fidelity audio and video, with the exception of operating system streaming solutions. Although a resolution to this issue will eventually appear, plan to spend time testing any applications that use audio/video.

Some applications may also require specialized hardware such as tablets, scanners and smart-card readers. Make sure to test each with the virtualization solution of choice.

## Remote Access

If your client virtualization solution needs to be accessed from remote locations, you will need to plan and design the solution in a manner

that permits the incorporation of each operating system, device and access methodology (DSL, cable modem or dial-up).

## Change Management

Both server and client virtualization solutions will need to carefully include any change-management solutions in place. Changes made to servers may already have a defined window, but changes to applications can likely happen on a more dynamic basis.

### Virtualization: Implementation Pitfalls

Businesses are required to show a positive and quick ROI for almost every IT initiative. Both TCO and ROI analysis have been used for the last few years to prove the value of virtualization projects. However, not every firm recovers their investment in the time originally anticipated.

For example, in some cases firms are only able to virtualize 20 percent of their infrastructure, even though 85 percent was originally estimated. One reason for this is the availability of personnel as well as financial resources.

While this type of situation isn't typical, it can happen. Here are some ways to avoid it:

1. Commit to not only the hardware/software investments but also the resources required to execute the project.
2. Commit to a reasonable timeframe for implementation and conversion. Also, consider scheduled downtime windows, which can limit your conversion timeframe.
3. Scrutinize the ROI analysis thoroughly. Some corporations may find later on that they cannot convert physical servers to virtual machines due to I/O or other hardware dependencies, lack of vendor support, unanticipated virtual licensing models, etc.
4. Develop a migration plan for P2V migration. A P2V project can affect multiple application groups so you have to put effective communications, logistics and fallback plans in place.
5. If you do not have internal resources available, consider outsourcing design, implementation and P2V work to an experienced partner.

## Virtualization: Next Steps

Both large and small businesses have come under increasing pressure to deliver computing resources in a cost-effective and just-in-time manner. Scalability and resiliency have never proven more critical than they are today.

Furthermore, their critical nature will only increase as more firms engage customers within global markets. Virtualization offers an answer to these pressures.

Virtualization consolidates physical infrastructure — such as servers, clients, and networking and storage resources, and leverages those resources to support many systems. It represents the culmination of many existing virtualization strategies in order to achieve maximum gains in infrastructure resiliency, scalability, power efficiency and operational cost savings.

In a conventional model, scalability tends to run in a linear fashion, with each application requiring yet another physical component. This results in the challenges that come with more physical space, more power and more heat.

By contrast, data-center virtualization takes a holistic approach to resource virtualization and efficiency. Its computing model aligns with today's objectives of cost efficiencies, doing more with less and emerging "green" initiatives.

### CDW Supports Your Virtualization Success

Companies of all sizes are realizing the benefits offered via virtualization. Besides the initial power and cooling savings, it can increase agility, enabling IT to respond rapidly to continually changing requirements.

CDW has helped thousands of businesses with virtualization. We likewise stand ready to assist your business in the following ways:

- 1. EXPERT INSIGHT AND CUSTOMIZED SOLUTIONS:** Your CDW account manager, along with technology specialists, will work with you to determine the best virtualization platform to meet your needs and build a custom server, storage, software and services solution.
- 2. COMPREHENSIVE SUPPORT SERVICES:** CDW provides comprehensive assistance — before, during and after your purchase. In addition to 24x7 online support, we offer the convenient My Account portal on CDW.com, giving you round-the-clock access to your latest order and purchase information, helpful online guides and the real-time status of your account team.
- 3. LEASING:** We offer flexible ways to help you finance your technology investment in a way that fits your budget.
- 4. ENTERPRISE CONFIGURATION CENTERS:** We can assemble and configure your virtualization solution into a rack, ready to deliver.
- 5. SERVICE OFFERINGS:**
  - a. Assessment Services:** CDW offers several server virtualization assessments to assist you in properly identifying which of your servers

should or shouldn't be virtualized. We also offer thorough TCO/ROI analyses via our Professional Services Consulting Team.

- b. Jumpstart Services:** If you're new to virtualization and need a quick boost to start your project, CDW's Jumpstart services can get you quickly moving in the right direction. These services provide onsite training and basic implementation — almost always in five days or less.
- c. Plan/Design and Upgrade Workshops:** Our customized virtualization workshop engagements range from two-to-12 weeks and involve detailed design, build and rollout planning/documentation.
- d. Health Checks:** CDW can perform health checks for existing virtualization systems to help determine bottlenecks and provide recommendations based on the best practices expertise of our vendors and field engineering teams.
- e. Custom Implementation:** Enterprise firms may require a combination of all of our services through a phased implementation or as part of another project. We can customize our services to meet the needs of any custom project as well as manage the project from start to finish.

### 6. HOSTED AND MANAGED SERVICES:

- a. Hosted Enterprise Infrastructure (HEI):** VMware data center virtualization technologies power this on-demand infrastructure. HEI enables you to increase or decrease processing cycles during seasonal spikes, deploy minimal disaster-recovery footprints until actual recovery becomes necessary, and avoid one-time hardware and software charges. Charges for the service are based on allocated infrastructure capacities of the CPU, memory and disk.
- b. Remote Managed Services (RMS):** Our RMS services support VMware environments located on user premises or other data center locations. CDW monitors VMware ESX hypervisor performance, utilization and system messages. RMS includes proactive planning for software and hardware patches. It also provides assistance with physical-to-virtual conversions, VMware ESX hypervisor optimization, load balancing and other administrative tasks.
- c. Remote Backup Services (RBS):** RBS employs industry-leading technologies to back up virtual machines to CDW enterprise hosting centers both securely and efficiently. Combined with CDW's HEI service, RBS enables firms to put together disaster-recovery solutions with minimal up-front costs and less than 24-hour recovery time and recovery point objectives.

To design a virtualized environment that supports all of your needs, turn to CDW. Working with your CIO, management team or IT department, we can assess, design and implement the right solution for your organization and provide ongoing management for your virtualized infrastructure. Consider us an extension of your IT organization — without the headcount.