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# *The Shortcut Guide<sup>™</sup> To*



# Implementing Virtualization in the Small Environment

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## Chapter 2: What Business Benefits Will I Recognize from Implementing Virtualization?

Small businesses and environments are indeed small due in many ways to their limited budgets. As such, the small business must leverage no-cost and low-cost tools wherever possible if they are to survive. They must be extremely careful about where they spend their money, making sure that every investment provides a direct and recognizable benefit back to the bottom line.

This focus is much different than what is typically seen in large enterprises. With large organizations, benefits are more easily classified in terms of operational efficiencies, with reductions in time and increases in agility directly equating to reductions in cost. Enabling improvements to manageability are a key concern when you have 1000 servers in your data center because their management involves a lot of time and cost. The small business, however, must look to whole dollar or “hard” cost savings when considering any cost outlay.

To that end, answering the question posed by this chapter requires a primary focus on hard dollar savings to be of benefit to the small environment. You’ll see just that focus in this chapter. Yet at the same time, this chapter will also discuss some of those other “soft” benefits that make sense. You might be surprised that even in the small environment, the addition of a “soft” benefit can in the end result in a recognizable “hard” return.

### Why Should My Budget Care About Virtualization?

As with many IT technologies, virtualization’s first play into the IT market was targeted directly towards the needs and demands of the enterprise organization. For enterprises, virtualization is an obvious and smart investment. The cost savings of reducing 1000 servers to 100 are easy to see. A 90% reduction in total server count, along with their power and cooling costs and all the associated administration improvements, makes a lot of sense for the very large environment.

Yet small environments can also benefit through the technologies first employed by the large corporations. For the small business environment, that same 90% reduction in physical servers may not reduce 1000 to 100, but reducing 20 to 2 results in just as striking a benefit to your cost basis. Those benefits obviously relate to your bottom line; at the same time, they go far in improving your business’ computing agility.

With this idea in mind, why should your budget care about virtualization? What are the benefits your small business or environment stands to realize from a virtualization rollout? Let's first look at a few high-level areas of return you can expect. With your virtualization investment

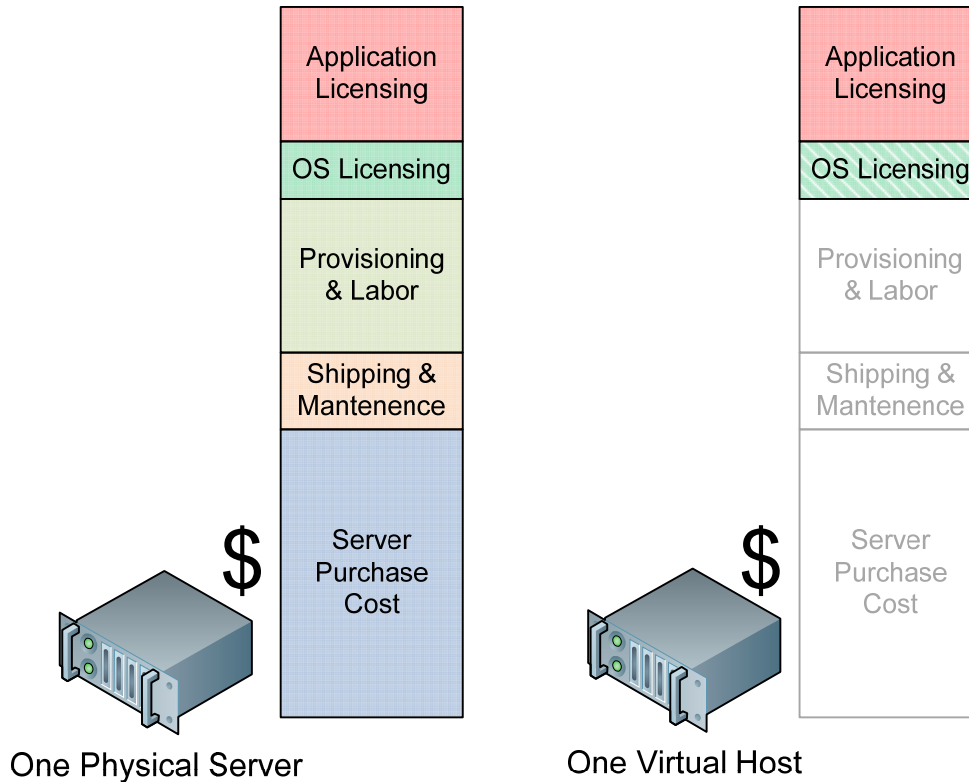
- You will save money on hardware and software
- You will save money on power and cooling
- Your entry costs will start low.
- You will leverage your existing infrastructure
- You will recognize improvements to your business services
- Your administrators are likely already familiar with this technology

All of these are pretty lofty statements. Yet each brings about a benefit to the business through direct cost avoidance, reduction in operational expense, or elimination/reduction of risk. For a more detailed analysis, let's take a look at each in detail.

## You Will Save Money on Hardware and Software

Virtualization's savings on physical hardware tends to arrive first with the need for future expansion. In the physical world, adding two additional servers to support a new business venture or management activity requires purchasing two new pieces of hardware, along with the necessary software and OS licenses, maintenance, and shipping costs associated with those servers. Additional manpower costs are required to provision those servers, install their OS, add applications, and generally prepare them for use.

In a virtualized environment, the infrastructure for servers is abstracted away from the traditional 1:1 relationship between server chassis and new business service. With a properly planned and managed virtual infrastructure, your environment will be configured to reserve sufficient processing power to support expansion. Thus, a need for two new servers does not require a requisition for two new physical servers. Fulfilling that need instead involves little more than provisioning them within the virtualization platform's management console. Although the manpower costs associated with application installations are generally the same, the other provisioning tasks—such as unboxing, mounting, cabling, and even the OS installation—are eliminated. Figure 2.1 shows a bar graph that illustrates these costs.



**Figure 2.1: Adding a new virtual machine to a virtual host eliminates many costs traditionally associated with adding new services.**

In Figure 2.1, you can easily see how the majority of the costs associated with bringing a new service online relate to its physical hardware. Buying new servers involves the cost for those servers as well as maintenance and shipping fees. That new server also incurs a marginal cost associated with getting it installed into your infrastructure. Racks, cabling, power and cooling, network connectivity and its associated infrastructure, and in some cases, shared storage are all potentially hidden costs that might not be accounted in the plans of many small businesses and environments. In short, *there are quite a few more costs associated with running a physical server than just the server itself.*

This is the situation displayed on the left of Figure 2.1. Now, contrast this situation with the virtual host shown on the right. There, the costs associated with purchasing the server, adding maintenance and shipping fees, and provisioning are all grayed out. This is the case because these components of these marginal costs are effectively zero. Adding that new virtual server to an existing virtual infrastructure requires no physical reconfiguration and involves no additional hardware purchases.

### The Laws of Physics Still Apply

There is an important caveat here: The costs identified are valid when your virtualization infrastructure has the residual capacity to support a new virtual server. As with everything else, virtual platforms must still obey the laws of physics. Any virtual platform will have a fixed amount of resources available to distribute to virtual machines based on the host's configured hardware resources. It then follows that at some point additional hosts—with all their associated costs—will be needed to support your future expansion.

Yet adding that new host is uniquely different. A new virtual host can support more than one virtual machine. Thus, depending on the resource needs of your virtual machines, adding a new virtual host is like getting many more than one new server for the price of one.

You should notice in Figure 2.1 that the costs associated with OS licensing are specially highlighted for the virtual host. This is due to the special virtual machine licensing benefits that are offered by some OS manufacturers. For example, Microsoft provides the following license benefit when using the Enterprise Edition of Windows Server 2008:

A Windows Server 2008 Enterprise license grants the right to run Windows Server 2008 Enterprise on one server in one physical [instance] and up to four simultaneous virtual [instances]. If you run all five permitted instances at the same time, the instance of the server software running in the physical [instance] may only be used to run hardware virtualization software, provide hardware virtualization services or to run software to manage and service the [instances] on the server. You may run instances of the Standard or prior versions in place of Windows Server 2008 Enterprise in any of the [instances] on the licensed server (Source: [http://download.microsoft.com/download/F/C/A/FCAB58A9-CCAD-4E0A-A673-88A5EE74E2CC/Windows\\_Server\\_2008\\_Virtual\\_Tech-VL\\_Brief-Jan\\_09.docx](http://download.microsoft.com/download/F/C/A/FCAB58A9-CCAD-4E0A-A673-88A5EE74E2CC/Windows_Server_2008_Virtual_Tech-VL_Brief-Jan_09.docx)).

Microsoft's rules for the Datacenter Edition of Windows Server 2008 provide an even greater benefit:

When Windows Server 2008 Datacenter is licensed for every physical processor in a server, the server may run the server software in the physical [instance] and an unlimited number of virtual [instances] on the licensed server. You may run instances of Windows Server 2008 Standard or Windows Server 2008 Enterprise in place of any Windows Server 2008 Datacenter in any of the OSEs on the licensed server. Unlike with Standard and Enterprise, with Windows Server 2008 Datacenter, the instance of the server software running in the physical [instance] may be used to run any software or application you have licensed. Because Windows Server 2008 Datacenter permits an unlimited number of simultaneous running instances on a licensed server, you have the flexibility to run instances of Windows Server in virtual [instance] without having to track the number of instances running or worry about being under-licensed.

In effect, the move to virtualization immediately increases your license count for certain OS versions by 4× or more. This benefit automatically expands your capacity for OS and virtual machine growth.

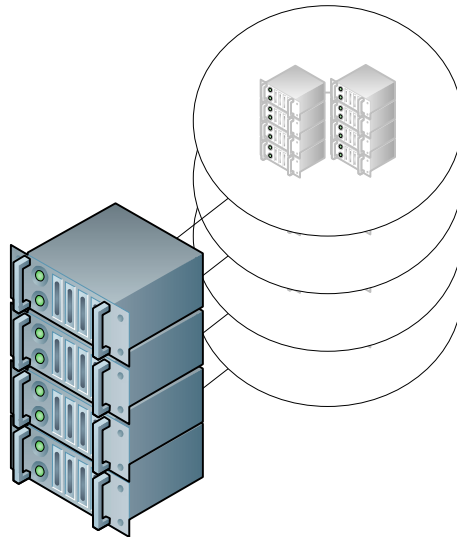
### **Application Licensing Is Not Necessarily Straightforward**

Be warned that although licensing for Microsoft OSs gains benefits, licensing for your applications can grow complex based on the specific language of the licensing terms. When installing applications to virtual machines, pay special attention to license language that focuses on processor-based licenses or server-linked licenses. These can have unexpected impacts on installations to virtual environments.

For a detailed discussion on special licensing considerations for non-OS Microsoft software, see the document titled “Licensing Microsoft Server Products in Virtual Environments” found at

[http://download.microsoft.com/download/F/C/A/FCAB58A9-CCAD-4E0A-A673-88A5EE74E2CC/Microsoft\\_Server\\_Products\\_Virtual\\_Environs-VL\\_Brief-Jan\\_09.docx](http://download.microsoft.com/download/F/C/A/FCAB58A9-CCAD-4E0A-A673-88A5EE74E2CC/Microsoft_Server_Products_Virtual_Environs-VL_Brief-Jan_09.docx).

Even if your goal is to consolidate just a few servers to a single host, your reduction in total server count frees those physical server chassis for new missions. As a result, the incremental cost of adding new services to your business drops dramatically. When the addition of a new service no longer automatically also requires a new server, you can quickly and inexpensively expand your business as you see fit. In the case of a large expansion, the cost savings alone in new computer hardware can often pay for a virtualization implementation’s initial costs right up front.



**Figure 2.2: With virtualization’s server consolidation capabilities, each new server purchase nets more than one virtual server instance, multiplying the benefits associated with its cost.**



## You Will Save Money on Power and Cooling

Hardware and software costs are not the only hard return gained by the organization that makes the move to virtualization. Costs associated with powering and cooling that server can similarly be avoided at a rate that is directly related to your level of consolidation.

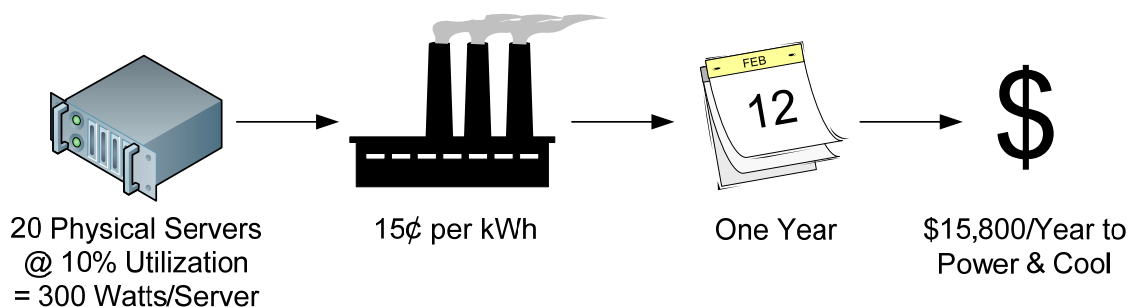
It is perhaps easiest to see this by looking at some real numbers. To give you an idea of the amount of money you are currently spending on merely powering your current servers, consider the following example. According to the power consumption calculator found at <http://h30099.www3.hp.com/configurator/powercalcs.asp>, the following server configuration consumes approximately 300 watts of energy at steady state and when processing at a minimum 10% utilization:

- HP DL385 Generation 5 server-class hardware
- 115V power
- 2.7Ghz Processor
- 8GB RAM
- A single PCI-E card
- Five 146GB SAS hard drives

As servers are generally operated continuously throughout their lifetime, this server's 300W of energy are required for 24 hours a day. If your average energy cost is 15¢ per kWh, each server of this type will cost you \$395/year to power. Twenty of these servers will cost you \$7900/year for power alone.

The costs don't stop there. As a rule of thumb, every watt consumed for a server's processing generates one watt of heat. Removing that heat requires air conditioning, a process that involves additional power. In general, every watt of heat requires another watt of energy to cool. Thus, for an environment that has perfect air conditioning—one that runs at 100% efficiency—you can assume that cooling your servers effectively doubles the costs.

Thus, as Figure 2.3 shows, to power and cool 20 servers of this type will require a recurring cost of \$15,800/year.



**Figure 2.3: 20 example physical servers can cost \$15,800 per year to power and cool.**

These costs can be even higher if you house your server infrastructure within an offsite hosting facility. To recognize profit, these facilities up-charge the costs for power and cooling while also charging for the space consumed by the server chassis itself.

As a result, there are dramatic hard cost benefits that can be gained through the consolidation of server instances onto fewer server chassis. This chapter has already discussed how the goal of achieving a 90% consolidation of servers results in a reduction from 20 to a mere 2 servers. This directly reduces your overall power and cooling costs by \$14,220 per year. Considering the average cost of server-class equipment required to support virtualization, the savings in power and cooling costs alone could buy an additional server each and every year to expand your existing virtual machine capacity.

### Your Entry Costs Will Start Low

You may at this point be asking, “For all these great cost-savings benefits, what will I have to pay to start?” This is an honest question, because at first blush, some virtualization platform software can appear expensive. However, that expected initial expense needn’t necessarily be high for small businesses and environments who consider the right approach to getting started.

For a small implementation, your initial cost outlay for a move to virtualization is likely to include some or all of the following components:

- **Virtualization platform software.** Most virtualization vendors provide an entry-level software edition at no cost that includes the basic features. Although there tends to be a standard set of features available across all no-cost solutions, there are notable differences between virtualization vendors. The next section will discuss some of the specific features you can expect to get from most solutions, but research your options thoroughly before deciding on a solution.
- **Maintenance and support.** Although the initial software acquisition for entry-level virtualization software involves no cost, the maintenance and technical support for that software will incur a minor cost per year. This maintenance and technical support is critically helpful to ensure that specialists are available in the case of an emergency. Virtualization effectively encapsulates the whole of entire business processing within its platform, so smart businesses should always consider the purchase of a minimum technical support contract as a risk-reduction measure.

- **One or more physical servers.** You will require one or more physical servers on which to install the virtualization software. Host resources are a primary indicator of the resulting level of performance once servers are virtualized, so these servers should be equipped as powerfully as you can afford. Additionally, the function of these servers should be reserved exclusively for supporting the virtualization environment. Due to the high-resource utilization seen on virtual hosts, it is not a recommended practice to leverage multiple roles for a virtual host.
- **Additional RAM memory.** Virtualization is heavily dependent on RAM, with more memory always preferred over less. More memory in a virtual host means that host can support more collocated virtual machines. With the cost of memory relatively inexpensive, this hardware upgrade quickly pays for itself by increasing your consolidation capabilities.
- **Additional storage.** Each collocated virtual machine requires virtual host disk storage that is equivalent to the real amount of disk storage that is configured for the virtual machine. Thus, if you want to collocate 10 virtual machines onto a single host and each virtual machine has a 40G hard drive, you can need 400G or more of storage to support this configuration. Be aware that some virtualization software technology requires real disk space for only the consumed portions of virtual disks rather than the entire assigned virtual disk. This technology can reduce your overall disk space requirements but must be closely monitored to prevent host disk space from being fully consumed.
- **(Optional) External, shared storage.** Direct-attached storage within a physical host is limited by the count and size of disks that can be installed to the server chassis. Thus, the capabilities of a physical server will eventually be bound by its disk space. External storage that is shared between multiple hosts and connected via fibre channel, iSCSI, or NFS tends to incorporate a greater expansion capability and to enjoy more high-availability features. This type of external storage is also a primary requirement for the advanced “motioning” capabilities discussed in the previous chapter.

Chapter 3 will go into more detail associated with the physical and logical elements you will need to get started with virtualization. However, the previous list is useful for helping you understand the cost impacts of those components. Discounting the last bullet—which can be an expensive addition—each of these components can be incorporated at very little cost.

With this information in mind, there are a number of architectural decisions that you will need to consider when planning your virtualization implementation. Those decisions relate to the features you anticipate needing, as well as understanding where additional costs can be applied to improve your performance, reliability, and overall management experience. Consider the following decisions and cost impacts when planning your virtualization implementation.

## Be Conscious of the Functions You Need and Don't Need

Entry-level and no-cost virtualization platforms focus primarily on basic server partitioning. This basic server partitioning embodies the technologies necessary to consolidate multiple virtual servers onto one physical host. With this basic server partitioning comes the core abilities to work with those machines as if they were physical computers. Your entry-level software platform will typically include the ability to

- Create virtual machines and run them concurrently atop a single virtual host
- Power on, power off, and suspend running virtual machines as well as adjust their physical configuration
- Interact with the console of a running virtual machine through some form of client interface
- Migrate virtual machines from one host to another while that virtual machine is powered off
- Support basic snapshotting functionality, enabling limited snapshotting and snapshot management of virtual machines
- Manage virtual machines and their hosts on a per-host basis
- Monitor the current and immediate-past performance of that virtual machine with a limited set of counters
- Support limited capabilities to adjust the power-on and power-off sequence for virtual machines after a host failure; this prevents the race condition where every virtual machine attempts to power on at once after a virtual host reboot
- Set and enforce limited roles and permissions for users who interact with virtual machines

For most small businesses and environments, these capabilities are enough to get started. The features in this list enable your environment to create, manage, and nominally interact with hosted virtual machines. However, there are additional capabilities that are gained with the movement from no-cost to for-cost virtualization tools. Although a discussion of specifics is best left for the next section, these capabilities focus on enhancing the management flexibility for running virtual machines as well as enabling them with high-availability features.

### Be Aware of the Paths for Future Augmentation

The basic features highlighted earlier are effective for small businesses, especially when considered alongside their entry cost. Yet it is important to recognize that the move to virtualization very quickly consolidates a lot of resources onto a small number of physical devices. As such, the loss of a single virtual host can be catastrophic if preparations are not made.

This need for business continuity in the case of a virtual host failure is a primary motivator for many small businesses to eventually jump to for-cost tools. Among other features, the add-on capabilities enabled by for-cost tools are focused on preventing this catastrophic loss of business processing. Consider the following as features that you can expect to see upon the upgrade to a for-cost virtualization platform:

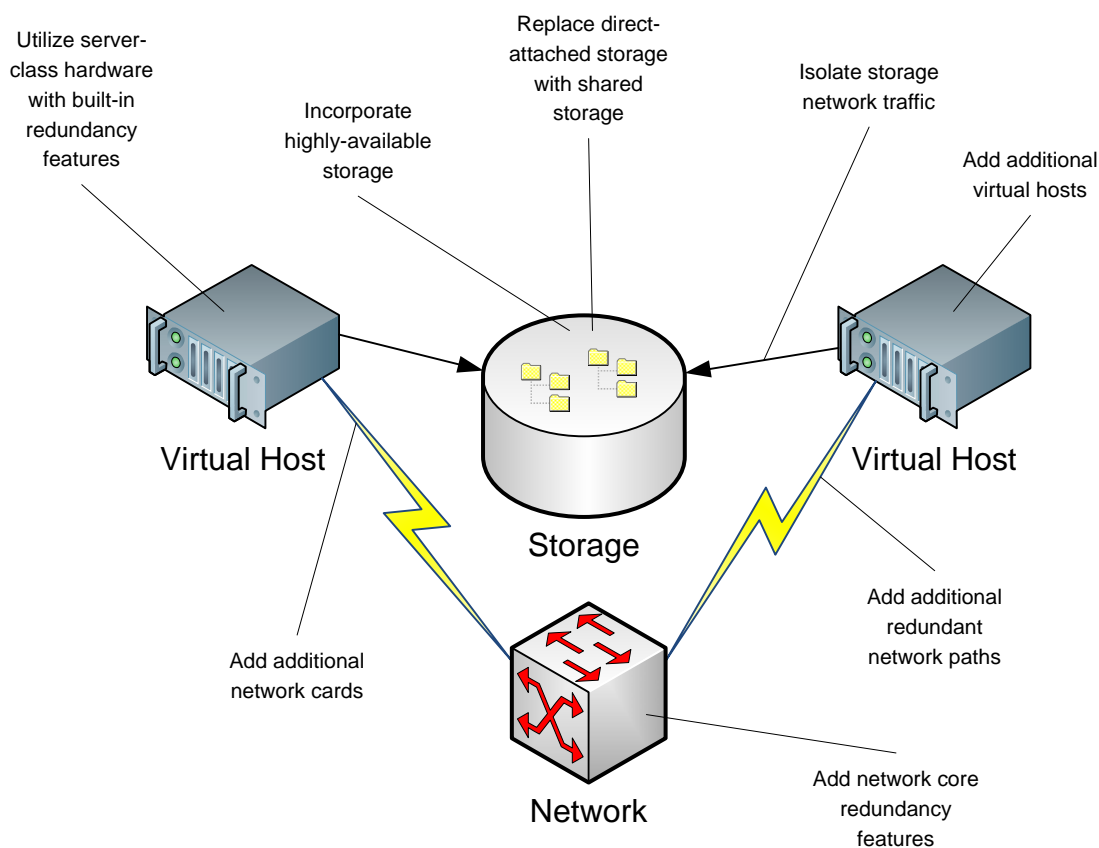
- Live migration capabilities that allow running virtual machines to be moved to an alternate host before a host failure
- Automated relocation to new hardware and restart of virtual machines immediately upon a host failure
- Load-balancing calculations that manually or automatically re-balance running virtual machines across hosts to prevent resource contention
- Disk storage migration that enables the zero-impact relocation of virtual machine disk files to alternate storage
- Integrated block-level backup capability for virtual machines, enabling the single-file backup of an entire virtual machine as well as guaranteed restore; some for-cost virtual platforms additionally offer the ability to perform individual file restores from an image-level backup—this feature is useful in speeding the recovery of individual files
- Automated replication features that copy backed up virtual machines to alternate locations for disaster recovery purposes
- Centralized management, enabling the administration of all components of the virtual environment as a single unit

All businesses grow, as do their computing requirements. The smart business will look for virtualization platforms that provide an easy migration path from early no-cost to later for-cost software. As your business grows more reliant on your virtual infrastructure, it is likely that you will find these additional features necessary. Ensuring that your virtual platform can scale to meet your needs is critical for its long-term viability.

### Be Attentive to Hardware Requirements and Upgrades

In the end, keeping those virtual machines up and running is the most critical goal of any virtualization implementation. Yet the software that embodies its platform is only part of the expansion goals for a virtual infrastructure. The architecture of your computing environment itself must also scale to support your growing availability requirements.

These architecture enhancements arrive with the measured upgrade of your entire computing infrastructure. Although these capabilities may not be necessary as your business or environment starts small, growth over time will eventually lead the smart organization to making careful purchases. Your goal with hardware upgrades will be to reduce or eliminate single points of failure within your infrastructure, which ultimately increases the reliability of your business services themselves.



**Figure 2.4: Additional hardware capabilities can be added to virtually every component of your virtual infrastructure to add resiliency.**

To fully support high availability, the computing environment architecture can be expanded in many ways, some of which are called out in Figure 2.4:

- Adding network cards or entire paths ensures that the network is not a single point of failure
- Moving from local storage to shared storage decouples the data storage layer from the processing layer, adding flexibility and greater resiliency
- Storage appliances such as NAS and iSCSI tend to include internal designs that reduce or eliminate points of failure
- Even the apparently simplistic act of isolating storage network traffic from production network traffic prevents network conditions from impacting a virtual machine's access to its disks

These hardware augmentations needn't necessarily happen at once. Your small business or environment can incrementally add layers of redundancy as requirements and budget allow. Decisions regarding implementing these added layers will need to be made alongside your needs to expand your capacity for more virtual machines through the addition of new virtual hosts.

## You Will Leverage Your Existing Infrastructure

Irrespective of what you want your environment to look like down the road, making the move to virtualization today requires technologies that you likely already have in place. Most no-cost virtualization solutions today can run atop your existing infrastructure. Some virtual solutions require newer features such as 64-bit hardware, hardware-based data execution prevention, and/or hardware-based virtualization extensions. Others provide similar experiences atop lower-end hardware. To get the most benefit from your virtual platform selection, look for one that supports the technology you have already purchased but that includes the support of future needed capabilities.

## Your Administrators Are Already Familiar with this Technology

The cost to educate IT staff on the use of virtualization technology can be a further expense. However, virtualization technology has been available for Microsoft servers for nearly a decade. For many, virtualization's first inroads into the IT data center actually began at the desktop level. These software applications enable the creation of virtual machines at an administrator's desktop, and are commonly used for testing and evaluating new technologies. They are also very popular with software developers in mocking up development and test environments.

As such, your systems administrators are likely already very familiar with virtualization's technologies and best practices. Although the specifics of your chosen virtual platform may require some skills training for your administrators, the overall cost to your company for moving to virtualization is likely to be much lower than with many technology insertions.

## You Will Recognize Improvements to Your Business Services

Once implemented, virtualization enables levels of flexibility that were not possible using traditional physical servers alone. This flexibility comes about through the commonality of server instances, enabling a uniform server configuration across every virtual machine. The proper use of snapshots during typical administrative activities ensures that changes can be rolled back should they result in a server failure or problem. Also, the ability to create and rapidly deploy server “templates” enables your business to quickly prototype the development and deployment of new services. Each of these benefits is discussed in more detail in the following sections.

### Uniform Server Configuration

When servers fail, their most impacting characteristic is often the differences in their physical composition. The installation of a patch might succeed on one server, only to crash another. One server’s device configuration might work well with an application while another may experience problems. This problem is exacerbated over time as business growth and the need for additional hardware mandates new server purchases. With time passing between each purchase, the composition of earlier purchased servers is not likely to be equal to those that are purchased later on. This dissimilarity between hardware makes the job of keeping servers running more difficult, more complex, and more prone to error. With virtualization, every virtual server is functionally the same as every other, making hardware-specific problems significantly less likely.

### Configuration Rollback

Virtualization’s snapshotting technologies mean that any change to a virtual server can be rolled back should that change not complete as expected. Administrators need only choose to “snapshot” the configuration of the virtual server—a typically manual step—prior to completing a change. If the change is completed successfully, the administrator can eliminate the snapshot and return the server to regular operations. If a problem occurs, “reverting to the snapshot” involves a few clicks in the server’s interface. This capability prevents unexpected problems from impacting the server’s operations. It further increases your servers’ reliability while enabling administrators to solve problems without impacting your business.

#### **Be Careful with Snapshots**

One word of warning with snapshots: Although server snapshots are a useful tool for rolling back a configuration after a problem, their long-term use can impact the overall performance of a virtual server. Administrators who invoke a snapshot prior to a risky configuration change or patch installation should remove the snapshot once the change is proven to be successful. Doing so ensures that the virtual server’s disk processing does not incur the added overhead associated with running changes through the snapshot. This overhead grows particularly problematic when multiple, linked snapshots are created for a single server.



### Rapid Service Prototyping

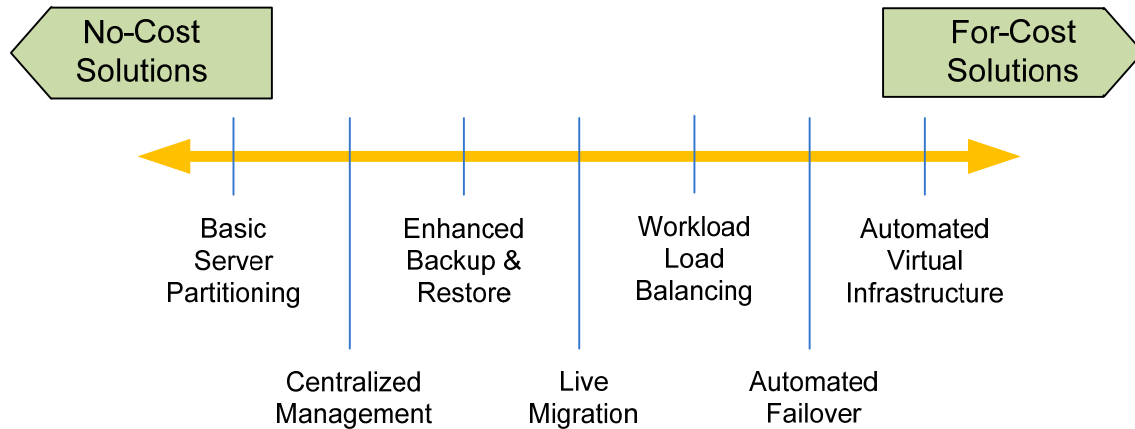
Many small businesses and environments shy from new IT projects due to limitations on available hardware. Most small environment budgets simply don't have the flexibility to purchase server hardware for mere service evaluation. Because of this problem, many times, new services are not properly evaluated prior to implementation. Others are not implemented at all.

Virtual machines bring flexibility to the small environment because they enable administrators to create entire mock-up environments atop existing hardware. When virtual servers can be created through a simple copy and paste, the process to create test and evaluation environments is extremely simple. Automation components natively available within some virtualization platforms can make this process even faster through the automated personalization of OSs. By giving your administrators the ability to evaluate new software and services prior to their implementation, you gain a higher likelihood of a successful implementation down the road.

### Virtualization's Spectrum of Technology, Cost, and Business Requirements

The intent of this chapter is to enable you with information about virtualization's potential benefit to the small business and small environment. These benefits start with the "hard" cost savings associated with virtualization's classic case studies: server hardware consolidation, power and cooling benefits, and software license efficiencies. However, although small businesses are likely to look first to these dollar-for-dollar budgetary impacts, virtualization's benefits improve operational efficiencies as well.

Some of these efficiencies can be recognized with the incorporation of virtualization's free toolsets. Others require the addition of for-cost features. Ultimately, a spectrum exists between "no-cost" and "for-cost" solutions and the capabilities supported by each. That spectrum, shown in Figure 2.5, starts with basic server partitioning and ranges through the desire for centralized management and the enhancement of backups and server restores. Businesses ultimately come to the conclusion that Live Migration capabilities are necessary to ensure virtual server uptime. With Live Migration comes the extra benefits of workload load balancing and automated failover. Mating virtualization's administrative capabilities with the right monitoring and automated actions eventually gets the small business to the point where large levels of their virtual infrastructure become automated.



**Figure 2.5: Virtualization’s spectrum spans from no-cost to for-cost solutions and the capabilities that each provides.**

The hard part is finding your business’ sweet spot on that spectrum for the capabilities you need in your environment and the ones you can afford. To that end, Chapters 3 and 4 of this guide will go into further detail on the steps necessary to make the move towards virtualizing your computing infrastructure. Chapter 3 continues the conversation by asking and answering the question, “What do I need to get started with virtualization?” There, you’ll learn about the technologies that virtualization relies upon, and which ones make sense for your business. Chapter 4 will continue by illuminating best practices associated with getting virtualization in the door. Its guidance will quick-start your IT teams with the right information they need to avoid many of the common pitfalls in any virtual implementation.

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