Virtualization:
Benefits of a “Candy Bowl” Strategy

A CIOview White Paper
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Virtualization: Benefits of a “Candy Bowl” Strategy

At the end of almost every child’s birthday party, each guest is given a self-contained goody bag. Controlling her own candy destiny, each child is free to decide when to eat a peanut butter cup (immediately) or when to have the dried fruit (never). Analyzing the costs and benefits of this approach, we realize that there are many factors that determine the true efficiency of such a system. The downside of the goody bag approach is that there are increased costs of all the individually wrapped candy. In addition, an adult has to put in the labor of purchasing all of the candy and making the bags. After you take into account the fact that children generally only eat those candies they like best, the amount of candy in the bag actually utilized is quite low – everyone wants to trade their dried fruit for a chocolate goody.

Certainly a more economical approach to providing sweets would be to set a large bowl out for all of the children to select from as they leave. However, such an approach would require many rules to be set. All the children would have to not rush to get their candy at the same time. There would also have to be rules about how many pieces each child could take and limits on how many of each kind of candy each child could have to ensure a good selection is still available for the last child.

Companies have generally adhered to the goody bag strategy for their Intel-based application(s). Traditionally, there has been one server for each application. This has been the approach because by doing so, it eliminates resource contention between applications; or in other words, all the kids running to the candy bowl at the same time. The goody bag strategy also improves reliability. If one child drops the candy from his goody bag on the floor, the other children can still eat from their respective bags; however, if one person overturns the community candy bowl, everybody goes hungry. However, the downside for companies is that most have hordes of Intel servers running at very low average utilization rates. Furthermore, IT systems are so complex that overall availability is low and IT staffing costs can be very high. Not that different from cleaning up after the birthday party!

Luckily, companies can dramatically reduce the number of servers deployed by implementing a server virtualization effort. Server virtualization brings all the benefits of the candy bowl strategy while at the same time preserving the isolation and orderliness of a goody bag. Virtualization involves creating multiple “virtual servers” on one physical server and assigning a certain amount of processing resources and resource priority to each virtual server. Just like a goody bag, each virtual server is a self-contained unit – it has its own operating system, own application software, and own virtual network. But just like the candy bowl, you can combine virtual servers on one physical location and utilize your resources much more effectively. In fact, virtualization can be as simple as combining two applications on a 1-processor server or as complex as running 64 virtual servers on one 16-processor physical server such as the IBM x445.

Virtualization: Benefits of a “Candy Bowl” Strategy

But I Want My Goody Bag!

Try to change candy delivery methods at a birthday party and you are liable to hear a chorus of voices shouting, “But I want my goody bag.” While IT managers, application managers, and technology end-users are typically more mature than small children, attempting to transfer to a virtualized environment can lead to the same kind of tantrums and tears.

So before you set off down the virtualization path, you might want to take stock of the potential benefits of virtualization as well as the possible downsides and pitfalls.

Virtualization has three key benefits:

- Reduced hardware acquisition costs from purchasing fewer servers
- Lowered facilities costs due to buying fewer servers
- Potential for lower personnel costs from managing fewer servers

Virtualization software allows you to subdivide one physical server into multiple virtual servers, each with their own independent operating system and application. Each virtual server actually uses the same exact resource; one simply assigns different priorities to set how much of that CPU’s time is dedicated to each virtual server. Software such as VMWare allows you to create up to 8 virtual servers per physical CPU (or 4 2-CPU virtual servers per physical CPU). However, actual performance limitations suggest that you should never create more than 4 virtual servers per physical CPU. Even so, this provides you with the potential ability to consolidate 32 separate departmental or workgroup applications onto one standard 8-CPU server.

Fewer Fancy Goody Bag Packages

One 8-way server, for example an IBM x445 with 8 2.8GHz Xeon CPU and 64GB of mirrored RAM, costs more ($162,010 each) than 32 individual servers such as Dell’s PowerEdge 1750 with 1 2.4GHz Xeon CPU and 2GB of RAM ($2,775 each). However, each physical server needs physical access to your IP Ethernet network as well as to any existing storage area network. If we assume that each server requires redundant network connections, then we must purchase 2 network interface cards (NICs) for each physical server as well as allocate a network port upgrade and maintenance cost. At roughly $691 per gigabit Ethernet card and $1,200 per year for network port costs, the three year network hardware cost of the 1 x445 is $2,582 in the first year and $2,400 for network costs for years two and three (total of $4,982). In contrast, we require 64 NICS and 64 ports for the 32 Dell servers for a cost of $121,024 in the first year and $153,600 for network costs for years two and three (total of $274,624).

A Total Cost of Ownership (TCO) Example of Virtualization

Virtualized		Non-Virtualized	
Components	**Cost**	**Components**	**Cost**
8-way server 2.8 GHz Xeon 64GB Mirrored RAM	$162,010	32 1-way 2.4 GHz Xeon 2 GB of RAM	$88,800
NIC Port Upgrade and maintenance	$7,382	NIC Port Upgrade and maintenance	$274,624
3-Year Cost	$169,392	3-Year Cost	$363,424
3-Year Cost with SAN	$175,902	3-Year Cost with SAN	$568,864

Source: TCOnow! for Industry Application Server Consolidation

The total costs are then $167,002 for the virtualized IBM x445 and $363,424 for the physical Dell 1750s. If you were to connect to a storage area network, you would also require two Fibre Channel host bus adapters per physical server at a cost of $3,210 per adapter. In other words, when you include all physical aspects of your infrastructure, virtualization has the potential of reducing your hardware-related costs by **50%** or more. Virtualizing your applications allows you to virtualize your various network elements (IP, Fibre Channel) and therefore substantially reduce the cost of your server-related hardware.

Space Savings in the Goody Bag Storage Department

Virtualizing your servers reduces more than just your hardware acquisition costs – you can also reduce the amount of space and power necessary. Instead of requiring separate rack space and power for each application, you now only need enough space to hold your actual physical servers. Let's take the above example of 32 separate 1-CPU servers or 1 8-CPU server. Each 1-CPU Dell PowerEdge 1750 requires 1U of rack space and a 325 Watt power supply; each 8-CPU IBM x445 requires 4U of rack space and 1,050 Watts of power. So 32 Dell servers would require 32U, or 80% of a rack while your 1 IBM server would require 10% of a rack. Each rack requires roughly 65 square feet (6.03 square meters) of clearance space; with data center rents in the United States ranging from $26 to $97 per square foot, this can amount to quite a lot of money.

Even assuming that you purchase 1 rack for each solution and you have no savings on rent, your power and cooling costs are likelier to be lower in a virtualized environment. Your total Dell power needs are 32 x 325 or 10,400 Watts; this amounts to 91,104 kilowatt-hours per year for power and an additional 31,093 kilowatt-hours per year for cooling. Your total IBM power needs are 1 x 1,050 Watts or 12,337 kilowatt-hours per year. At an average cost of $0.065 to $0.112 per kilowatt-hour, the cost of power in the United States could be up to $13,686 per year for 32 separate servers or $1,382 per year for 1 server running virtualization software. This is an annual cost difference of $12,304 per year or **90%**.

A Total Cost of Ownership (TCO) Example of Virtualization

Time Savings in the Candy Distribution Process

The easiest way to provide candy at a party is to simply dump everything into one big bowl. Creating individual goody bags requires far more duplicate effort. IT departments cannot escape these economics even with virtual servers since each virtual server has its own metaphorical candy assortment – staffers must duplicate effort spent managing patches, OS upgrades, troubleshooting, and application monitoring. However, you can enjoy savings on the effort needed to manage the physical environment running your virtual servers. For example, you may be able to save time installing and rebuilding physical servers. Or you may be able to simplify capacity planning and hardware troubleshooting tasks because you are now dealing with fewer physical resources.

In addition, virtualization software such as VMWare provides a number of management tools that simplify some of your operating system maintenance activities. For example, you can typically reduce the time needed to install an operating system from 8 hours down to 2 hours, a **75%** reduction. Or you can expect the amount of time needed to monitor your application performance and status to decrease by **30%**.

Cutting down the number of physical servers to manage and improve your efficiency at application and operating system management can never be as effective as a true Application Consolidation or candy bowl strategy. However, the typical IT shop running a set of Windows applications might expect savings ranging from 23 hours per FTE per year for High Performance applications (database, business intelligence, etc) up to 197 hours per FTE per year for Infrastructure applications (file and print, LDAP/firewall, etc). Assuming a fully burdened cost of $42,974 (a rural Wyoming school district) up to $115,982 (an urban West coast IT company), your savings can range from roughly **$500** per FTE per year to as much as **$11,000** per FTE per year.

Of course, virtualization is no magic solution. Server virtualization has three major drawbacks, namely:

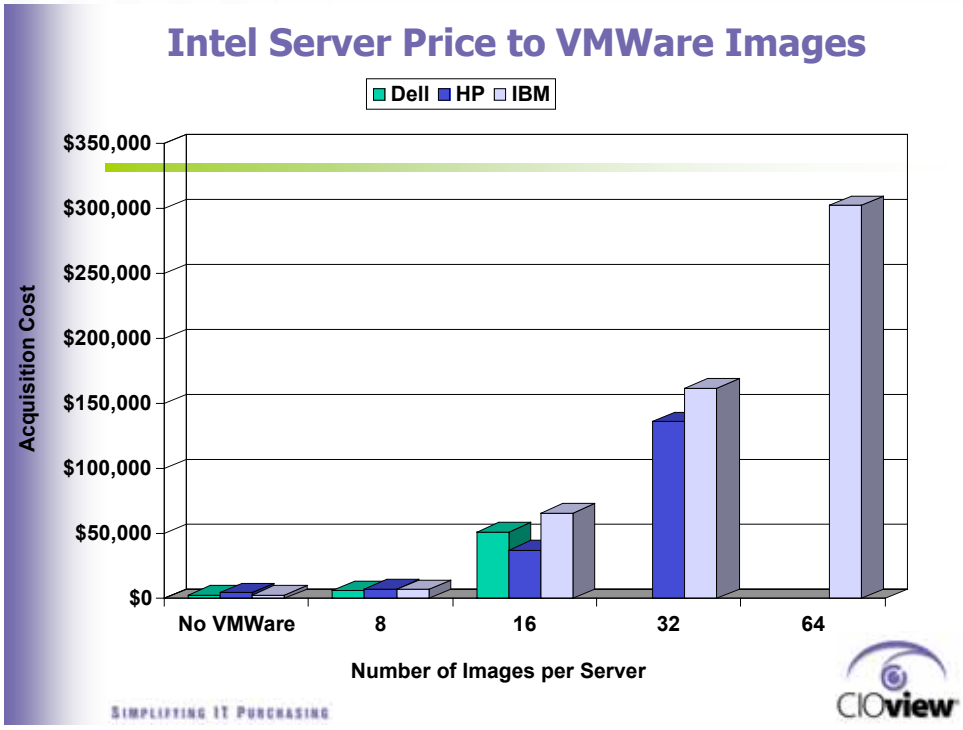
- High upfront server and software costs
- Performance limitations due to virtualization software
- More centralized points of failure

Buying a Candy Bowl and Separate Goody Bags Costs More

Virtualization requires you to spend more money upfront on your actual physical servers as well as your virtualization software. Larger symmetric multiprocessor servers such as 4, 8, and 16-CPU servers are priced at a premium relative to the smaller 1 and 2 CPU servers that are designed to run single applications. This is especially true as you add self-healing and self-managing Autonomic Computing features such as memory mirroring and the ability for a server to run even after a processor fails.

You should expect a premium of roughly 3x for each unit of relative performance as you move from Xeon Dual-Processor to Xeon Multi-Processor servers; as you add CPU and self-healing features up to an 8-way server, your premium will grow to about 7x for each unit of relative performance. If you intend to really leverage virtualization technology and use a 16-CPU server divided up into a very large number of virtual servers, you might have to pay a premium of **9x** to **11x** for each unit of relative performance.

A Total Cost of Ownership (TCO) Example of Virtualization

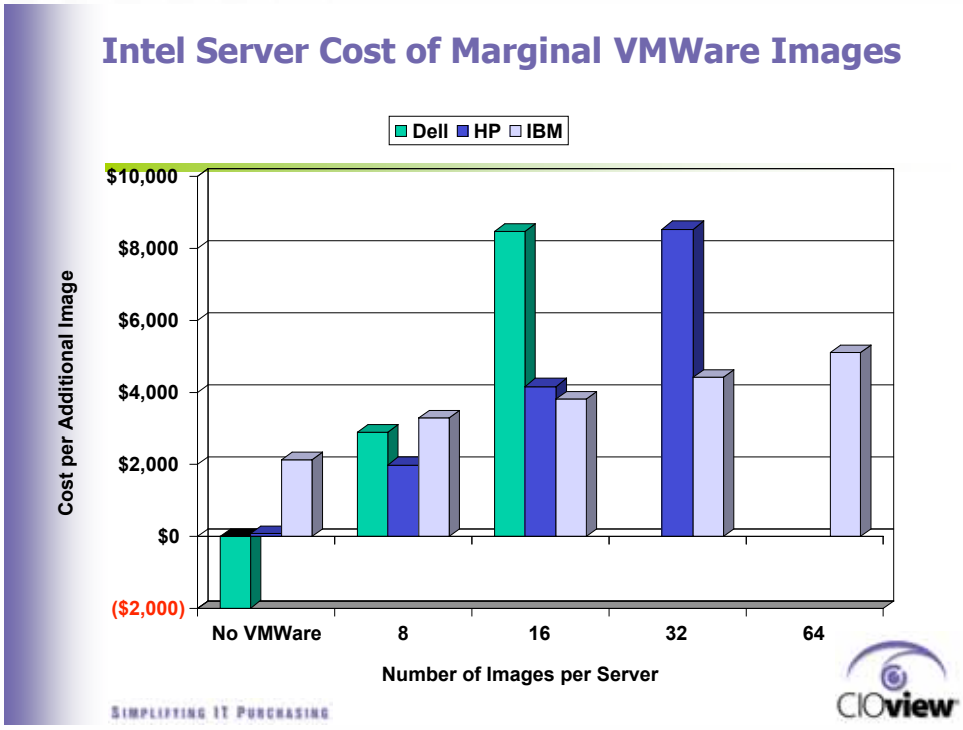


Of course, virtualization works best with low-utilization low-capacity workloads that require few system resources. The idea of paying a premium for relative performance that you don’t even need seems counter to the whole point of virtualization. To make sense of the problem you need to look at the other constraint on virtual machine consolidation – the virtual machine software. Most virtualization experts suggest putting no more than 4 production images on each processor; so if you want to consolidate from 32 servers to 1 server you must use at a minimum an 8-CPU server. Unlike capacity planning, estimating the software-related sizing uses 1 very simple formula:

Number of Servers = Number Virtual Machines * (1 CPU / 4 virtual machines) / (CPU per Server)

So your consolidation capabilities match a similar relative price curve as your capacity capabilities. As you can see on the first graph of server cost to virtual machines per server, there is a premium of roughly 1.2-2x per virtual machine as you increase the potential number of consolidated images. The second graph, the marginal cost to add capacity for a new virtual machine, shows that this premium rises as you add new images. For Dell, HP, and IBM, the marginal cost gets highest as you reach the end of each vendor’s product line in terms of server size (4, 8, or 16 CPU) and images per server (16, 32, 64).

A Total Cost of Ownership (TCO) Example of Virtualization



Our example comparing one 8-CPU server to 32 1-CPU servers showed that we would have to pay $162,010 for the 8-CPU server and only $88,800 for all 32 smaller servers; the acquisition costs for the virtualized server are **82%** higher. Even if you factor in support and maintenance for years two and three (year one is included in the hardware purchase warranty) at $1,356 per 8-CPU server and $562 per 1-CPU server, your costs are $164,722 and $124,768; your virtualized solution’s server costs are still **32%** more expensive.

In addition to the cost of your physical servers, you must purchase your virtualization software for your actual server AND guest operating system software licenses for your virtual servers. Let’s take our example of an 8 CPU server running VMWare to create 32 virtual servers each running Windows Server 2003. This setup requires an 8-processor VMWare license ($15,000 per server with $3,150 per year for support and maintenance) as well as 32 licenses of Windows Server 2003 ($1,199 per virtual server with $215 per year for support and maintenance). So your software license acquisition costs for the virtualized solution would be $53,368 initial costs while your support and maintenance costs for years 1 through 3 would be $30,090; your total software cost would be $83,458. In contrast, your software license acquisition costs for a non-virtualized solution would be $38,368 while ongoing support and maintenance for three years would cost $20,640; your total non-virtualized software cost would be $59,008. In other words, adding virtualization software increases your software acquisition and support costs by **41%**.

A Total Cost of Ownership (TCO) Example of Virtualization

Imaginary Goodies Are Not Perfect Substitutes for the Real Thing

While software virtualization allows you to create virtual divisions between a server’s actual processing resources, these virtual servers are not exactly the same as a real machine. Imagine your application as a stack of layers sitting on top of each other: At the top is the application itself; below the application is your operating system which tells the application and the server how to behave; below the operating system is the actual server itself that delivers your processing capacity. Virtualization adds an extra layer of complexity to this neat tripartite order – you now have a virtualization layer between your operating system and your actual server. Instructions from your application must go to the original operating system, sometimes referred to as the guest OS, then to the virtualization engine, often referred to as the host OS. This extra layer of complexity typically reduces virtual server performance by 15%.

Each and every application will run less efficiently when virtualized; this means that you will need somewhat more capacity in a virtualized environment to do the same work. Most likely this extra capacity need will be far outweighed by the savings from running your server at a higher utilization but you may find that more CPU-intensive applications actually require a larger number of physical CPUs in a virtualized environment. If your software is priced on a CPU basis, for example an engineering or statistics package, your license costs may rise.

Sending the Children Home

Finally when the birthday party is over, the candy distribution issue is solved for one more year. Virtualization, on the other hand, is something you will have to contend with constantly. It will become an endemic part of IT lexicon and it will permanently change the economics of servers and storage.

About CIOview

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CIOview has created 55 distinct products all of which use the same desktop player application and a product-specific content module. This provides customers access to a complete portfolio of business case analyzers for all of their IT purchase decisions.

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