Virtualization: Not Just for Big Business

A virtualized data center is a more nimble, responsive, and efficient data center. This report discusses the trend towards x86 virtualization and customer benefits, and examines how (in defiance of conventional wisdom) SMB customers have been embracing – and benefiting from – x86 virtualization at about the same rate as larger enterprises. Finally, we take a look at how two of the IT industry's virtualization leaders, IBM and VMware, have joined forces to help their SMB customers take advantage of the many benefits x86 virtualization can provide...

A virtualized data center is a more nimble, responsive, and efficient data center. Virtualized data centers get much more productive work out of their systems, use less energy and floor space, and have higher personnel productivity. With virtualized systems, customers can respond to constantly changing IT needs much more quickly and effectively than they can with single-application discrete systems.

Virtualization has long been used in the mainframe and large system world as a safe and reliable method of improving IT efficiency. The big news is how x86 server virtualization technology is now ready for prime time. Virtualization will have the biggest impact (providing the greatest benefit to the greatest number of organizations) when applied to the truly massive numbers of x86 servers that have been multiplying amoeba-like in most organizations.

In the x86 world, there are two broad types of virtualization: O/S Virtualization and Hypervisor based virtual machines. O/S virtualization mechanisms use a single instance of an operating system (Windows or Linux) to, with the help of the virtualization software, host a large number of individual workloads. It's kind of like how Windows on a personal computer can have Word, Outlook, Excel, and a whole bunch of other workloads open and operating at the same time.

The hypervisor approach is completely different. A hypervisor is code that sits between the guest operating systems and the hardware. The guest operating systems can be various versions of Windows and Linux, which can be mixed and matched on the same system. The hypervisor makes sure that each operating system instance gets its proper share of HW resources and also ensures that activity in one virtual machine (or partition) can't negatively impact any other partition or the overall system.

These two methods aren't mutually exclusive. Each has strengths and weaknesses, and each has a place in most data centers. Currently, the hypervisor approach is much more popular in the market, with VMware owning the lion's share.

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### Virtualization Benefit: Utilization

The benefits from virtualization, particularly on x86 systems, are profound. The first and most dramatic improvement is in the area of system utilization. The average utilization rate for a typical x86 server is only about 6% - a shockingly low figure, and often a surprise to data center managers. This isn't to say that there aren't any x86 systems running at higher utilization rates; these systems definitely exist, but in almost every data center, the systems that are hitting the stops on the high side have many more barely idling boxes sitting right next to them.

The reason for this dismal situation is due to the traditional x86 usage model where a single server only hosts a single workload. Under this model, bringing a new application into the data center spawns multiple new boxes – one (or more) for production, a box for testing, a box for development, and perhaps even more boxes for training or failover needs. While the production server might see some high usage peaks from time to time, the test and development systems are often used only sporadically – lowering the average utilization rate for the entire data center.

Virtualization can quickly and easily improve average system utilization rates from the low single digits into the 50% range or higher (depending on workload and application characteristics). The benefits arising from this are impressive. The most obvious is that customers will get much more use out of their systems, and thus be able to postpone the purchase of new hardware. The fewer systems on the floor, the fewer systems that have to be maintained, managed, and secured – helping to reduce the workload on staffs that are usually stretched pretty thin.

Virtualization Benefit: Energy & Facilities

Virtualization is also one of the best ways to improve facilities issues. Currently, there is a lot of attention being focused on data center energy usage, with vendors rushing to bring out more energy-efficient offerings. Implementing virtualization pays significant dividends on both energy usage and floor space requirements. The impact on floor space is obvious – if you're running the work of five or ten systems on a single system, you can remove the excess boxes and free up quite a bit of space.

System Utilization vs. Actual Power Consumption
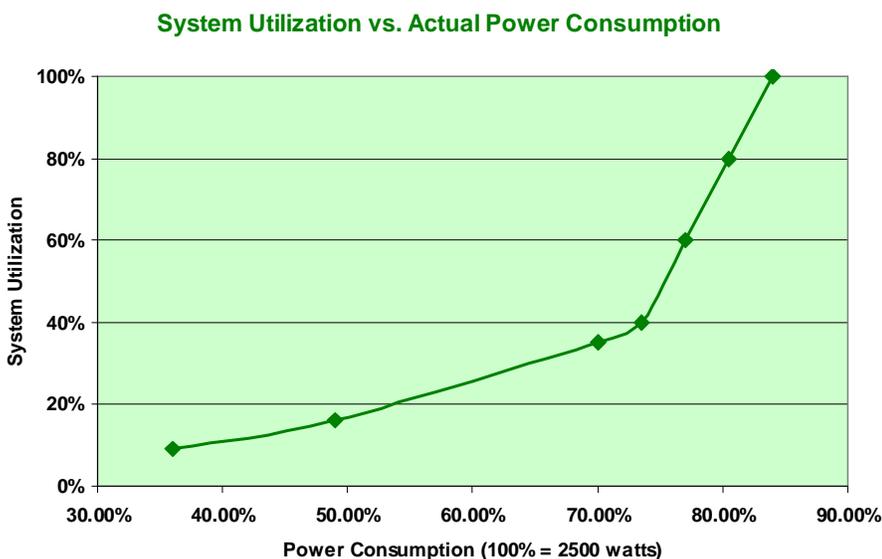
How virtualization impacts energy costs is only a little more complicated. The easiest way to explain it is to consider that you can divide the energy use of really anything into two types: fixed and variable. When you start your car or boot a server, they both consume a certain amount of fuel (or electricity) while idling and, of course, more fuel when running flat out.

With servers, there is a considerable amount of 'fixed cost' energy consumption – the juice consumed by the (often only 80% efficient) power supply,

the power needed to run the fans, spin the boot disk, charge up capacitors, etc. The chart on the previous page clearly illustrates what happens to actual power consumption as a system goes from idle to max utilization. The data used in the chart was provided by a client and is accurate for the particular x86 system they analyzed. The shape of the curve and the location of the inflection points will vary depending upon the architecture of the server. However, it is a good example to show the general correlation between energy consumption and system usage.

At idle, the system already draws about 37% of its total electrical capacity. At 40% system utilization, it consumes 75% of maximum power. This is where we see a major inflection point. As utilization rises to 100%, the corresponding power draw rises at a much lower rate. In other words, the 'variable cost' component of server power consumption is relatively low. In real terms, this means that using the extra **60%** of a server's capacity only costs an additional **10%** in electricity (bringing total power consumption to ~85%). The obvious question at this point is why the power consumption tops out at 85% rather than 100%. The answer is because the nominal power ratings of systems (along with many other products) represent absolute maximums and very often overestimate the actual maximum draw by a significant margin.

Given that power consumption is closely related to heat output, it would lead one to believe that the extra cooling load is commensurately modest. If your goal is to save energy and go green, moving to a virtualized infrastructure is a solid first step.

Virtualization Benefit: Speed & Flexibility

Virtualization also pays off by making it much easier and faster for IT shops to respond to changes in IT demand. New workloads can be brought up in minutes by simply firing up a new operating system instance, loading the application, and then provisioning the server. Contrast this to the usual ordeal of having to spec out and purchase a new system (or systems), and then wait days or weeks for delivery and physical installation. The ability to bring up new systems quickly also goes a long way towards addressing application scalability problems. For horizontally scaled applications, new instances of an application can be brought up quickly enough to handle spikes in demand. With VMware, this process can be automated to ensure an even more timely response. Vertically scaled applications can be dynamically given more hardware resource to handle demand surges, or moved to a larger system – without having to take the application down - by using VMware's Vmotion feature. This same feature can be used to move workloads off of a system in order to perform maintenance. VMware also has the ability to take and store snapshots of virtual machines that can be stored and replicated offsite to enable fast disaster recovery.

The bottom line in x86 virtualization is that it allows IT organizations of all sizes (as we will see in the next section of this report) to get much more work out of their technology investment. The financial benefits from less spending on systems, management, maintenance, and facilities are significant – with conservative estimates ranging from 25-40%. The intangible benefits from the additional flexibility and application availability are more difficult to quantify, but may be even more significant in some organizations.

Virtualization and the SMB

Conventional wisdom is that while the move towards virtualized x86 systems is beneficial, it really pays the highest dividends for the large enterprise, with its hundreds or thousands of systems and petabytes of storage. The thinking is that small and medium-sized businesses (SMBs, usually meaning 1,500 employees or under) don't have nearly the same size IT infrastructures and thus

don't have the same problems as their larger brethren. Another factor is the assumption that SMBs don't have the IT personnel bandwidth, or even the technical sophistication, to tackle virtualization.

It is our belief that virtualization and consolidation offer solid benefits for organizations of almost any size. We're also constantly surprised at the size and sophistication of many SMB IT operations – the number of employees and annual revenue don't necessarily correlate to the level and amount of technology needed to run the business.

"We are virtualizating our x86 servers"

|	Disagree	Not Sure	Agree
■ %SMB	22.58%	6.45%	70.97%
■ %Non-SMB	17.39%	4.35%	78.26%
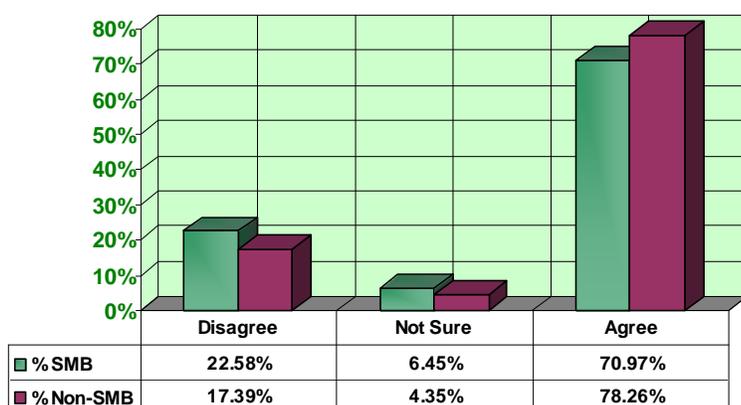
As part of our 2Q'07 x86 Vendor Preference Survey (297 total enterprise respondents, 39% SMB), we asked real-world data center managers questions covering their perceptions and relationships with vendors, plus questions covering a number of other critical data center challenges – including virtualization. For purposes of this report, we separated the responses of SMB data centers from those of larger organizations in order to see if organization size had any impact on the tendency to virtualize or the benefits received from virtualization.

Our research shows that SMBs are embracing x86 virtualization at almost the same level as enterprise customers, and, more importantly, getting the same level of benefits from the new technology.

As can be seen on the accompanying chart, fully 70% of SMB respondents are implementing x86 virtualization to at least some extent. This compares very favorably to the 80% of enterprise customers who said the same thing. It's interesting to look at the negatives on this question, where only 23% of SMBs have no virtualization plans compared with 17% of larger enterprise respondents. While x86 virtualization technologies have been around for a few years, it is only now really gaining momentum in the industry – given this, we expected to see SMBs feel a little more skeptical about the trend.

Achieving Higher Utilization Rates with x86 Virtualization

	Disagree	Not Sure	Agree
■ %SMB	32.26%	21.51%	46.24%
■ %Non-SMB	29.35%	18.48%	52.17%
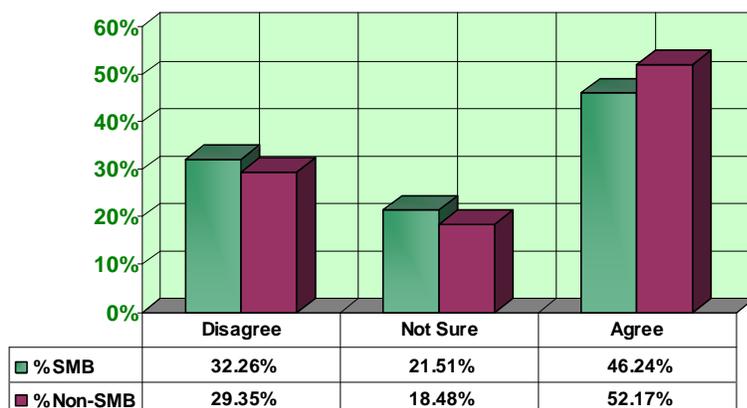
Given that the large majority of SMBs, at least according to our data, are implementing x86 virtualization, the next question is whether they are seeing significant benefits. Again, we parsed our data to isolate SMB respondents from their larger counterparts, with the results in the following charts.

We again see striking similarity between SMBs and large enterprise customers on the question of whether

they are realizing higher hardware utilization rates on their virtualized systems. Roughly half of the respondents in both camps report better system utilization rates, while about 20% of each aren't quite sure where they're at right now. A third say that they haven't really seen higher system utilization at this point, but their qualitative comments lead us to believe that this is a temporary condition due to their still being in the early-adopter phase of implementation.

System manageability, or, more accurately, the lack of manageability, is one of the more vexing problems in most data centers. For some, the idea of stacking applications on a single server, particularly an x86 server, seemed like a management nightmare that would make an already difficult task even more complicated.

"Virtualized x86 servers are easier to manage"

|	Disagree	Not Sure	Agree
% SMB	13.98%	35.48%	50.54%
% Non-SMB	34.78%	16.30%	48.91%
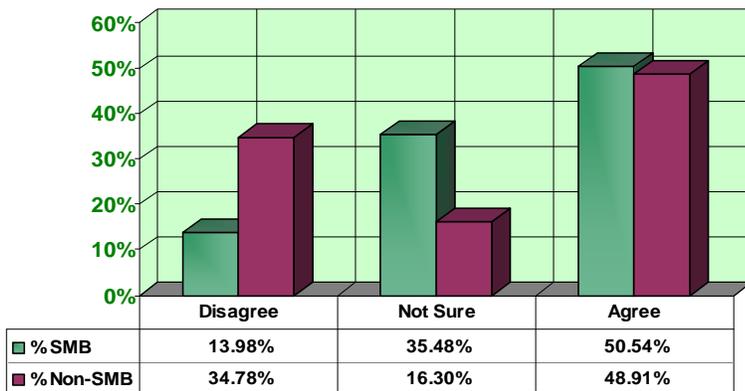
However, our data contradicts this notion, with half of both SMB and non-SMB respondents saying that their virtualized multiple workload systems are actually easier to manage than their previous single app - single server configurations.

This result also contradicts the idea that SMB data center personnel don't have the technical chops to either implement or manage virtualized infrastructures. If they were having problems managing virtualization, this is where it would show up. It is also interesting to note that 35% of non-SMB customers are essentially saying that they find virtualized servers harder to manage. Only 14% of SMB data center respondents support this opinion – a significant difference that might indicate that SMB IT shops are a bit more sophisticated than previously believed. This also says quite a bit about just how far virtualization technology has come in the last few years – both in terms of ease of implementation and in day-to-day virtual system management.

"x86 Virtualization saves us money…"

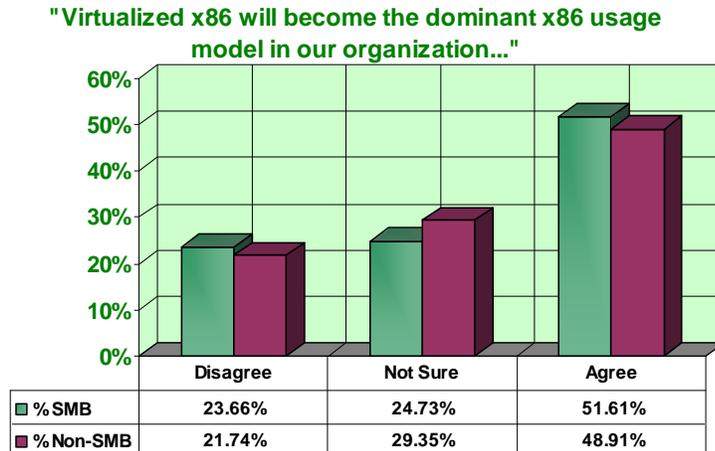|	Disagree	Not Sure	Agree
% SMB	20.22%	26.97%	52.81%
% Non-SMB	22.83%	15.22%	61.96%
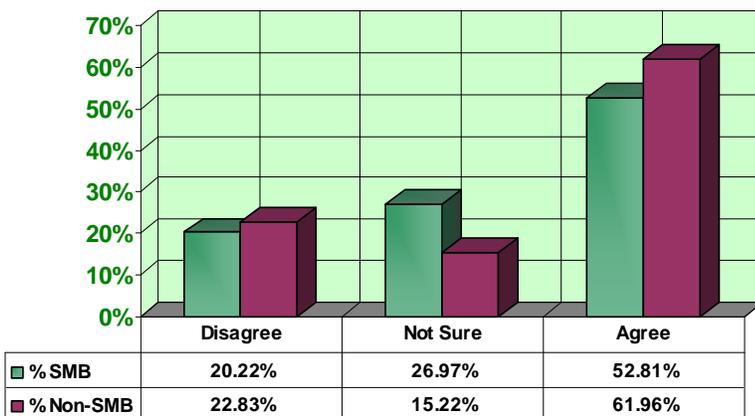
Over half of our SMB respondents report that their x86 virtualization efforts so far have saved them money. Only 20% say that they have not seen a beneficial financial impact from their virtualization projects to date. A large number – over a quarter – aren't sure if they're saving money or not. The primary reason for this is in the nature of how x86 virtualization initiatives evolve.

The vast majority of these projects begin life as sand boxes and pilot projects that grow over time. In most cases, there is little or no cost associated with these projects, and thus no detailed financial justifications are required. Even on larger virtualization efforts the investment is usually modest,

and, even with the purchase of new and more scalable x86 systems, the overall cost is usually well within most capital budgets. Of those organizations that do perform pre-virtualization cost justifications, very few of them do a post-virtualization analysis to ensure they are actually realizing their predicted savings.

"Virtualized x86 will become the dominant x86 usage model in our organization..."

	Disagree	Not Sure	Agree
☐ % SMB	23.66%	24.73%	51.61%
☐ % Non-SMB	21.74%	29.35%	48.91%

Perhaps the most solid endorsement of the overall value of x86 virtualization - for both large and SMB enterprises - is that fully half of all respondents believe that the virtualized x86 usage model is the wave of the future for their organizations.

The number of respondents who disagree with this is relatively low – 24% for SMB and 22% for non-SMB respondents. Given that a certain percentage of people will disagree with almost any proposition, especially one that is new, different, and will impact their jobs, we think it's noteworthy that *only* 22-24% of respondents are naysayers.

As we see from the data above, both SMB and non-SMB customers are generally sold on x86 virtualization. Moreover, the large majority of those who have dipped their toes into the virtualization waters are finding that the payback is significant. Still, there are some impediments to adoption, regardless of the down-the-road benefits. While the tendency to virtualize and the benefits received from virtualization are not dependent upon organization size, we have found that the virtualization roadblocks faced by IT shops do vary according to data center and organization size.

First, technology isn't the problem. The large majority of data center workers understand virtualization technology and have confidence in their ability to implement and manage virtualized servers and storage – this is true in both large and small organizations. In big companies, most of the hurdles involve inertia ("if it ain't broke, we don't mess with it"), and culture/politics ("the business units own the boxes; we're just responsible for keeping them running, but don't have the authority to change anything").

In SMBs, the problems are markedly different. Their smaller staffs and budgets can constrain their ability to tackle projects that are outside the normal work of keeping everything up to date, secure, and available. These SMBs often have extensive IT assets and can certainly benefit from virtualization, but they may not have the cycles to pull off the projects. We have also found that some SMB customers overestimate the time and money needed to implement virtualization. They also are often unaware of the range of products and services that have been specifically designed to place x86 virtualization well within the reach of almost any SMB customer.

IBM & VMware Bring Virtualization to the Masses

Two of the leading vendors in the information technology industry, IBM and VMware, have joined forces to make it easier and less expensive for SMBs to implement x86 virtualization. From a system perspective, IBM has the longest virtualization heritage in the industry and the IBM

mainframe is still the unchallenged virtualization champion – the system of choice for many of the most demanding organizations in the world. IBM is leveraging their mainframe knowledge and technology to build a range of x86-based systems (branded as IBM System x) that can not only fit into any IT budget, but also provide the performance, manageability, and availability that is a step above many of their competitors.

The major differentiator for IBM's System x family is that these aren't 'off the shelf' systems. You don't want to run multiple important applications on just any garden variety white box – the business consequences arising from poor performance or availability are too high to gamble on hardware that isn't enterprise class. IBM has invested heavily in designing custom components in order to provide a higher level of performance, scalability, and availability. IBM offers x86-based systems ranging from single-socket, 1U rack-mounted servers to their x3950 system that can scale from 4 sockets and 64GB all the way up to a 16-socket, 256GB memory server. In designing x86 systems, it's clear that IBM has anticipated the industry trend towards virtualization. Their systems can usually be configured with more memory than the competition – a critical factor on virtualized systems. Most performance bottlenecks on virtualized systems are due to a lack of physical memory.

IBM has integrated sophisticated availability features into these systems, features that are designed to minimize both planned and unplanned downtime. For example, scalable IBM System x systems have Predictive Failure Analysis (PFA) which can provide up to 48 hours' warning of an impending hardware failure. While other vendors offer PFA on memory, hard drives, and sometimes processors, IBM covers all of these components plus power supplies, fans, and voltage regulators. IBM systems also tend to have more extensive hot-swap capability – meaning components can be replaced without taking the system down, which is very important for virtualized systems.

One of the strongest features of IBM's System x line is their IBM Director systems management suite. IBM Director gives users the ability to manage any IBM hardware (including non-x86 servers and storage arrays) from a single console, either on-site or remotely. The real benefit from Director is that it helps organizations standardize their management tools, thus allowing managers to learn how to use one single and comprehensive tool rather than a hodgepodge of point products that may or may not work well together. Director is also uniquely suited to x86 virtualization due to its ability to monitor and manage VMware virtual machines.

As we mentioned above, VMware is the market leader for x86 virtualization software – with perhaps as much as 75% market share. Their innovative virtualization products allow multiple guest operating systems, and their associated workloads, to run on single systems. The VMware software provides isolation between virtual machines to the degree that a problem, or even an outright o/s crash in one partition, cannot negatively impact the workloads running in any other partition on the system. There is a lot of flexibility in the VMware usage model. Physical resources such as processors (or fractional shares of processors) and memory can be devoted to particular partitions on either a fair-share basis or in non-equal shares to ensure that more important workloads get a larger share of the system. Using VMware virtualization products, users can set up multiple Windows or Linux partitions which can be optimized for the particular workload they will be running, perhaps with different patch levels or an entirely different o/s version.

One of the most interesting aspects of VMware (on selected versions) is their Vmotion feature. Vmotion gives customers the ability to move active applications from one physical system to another – without powering down either the system or the application. This feature is most commonly used to take workloads off of a system so it can be taken down for maintenance

purposes, or to move applications that need more hardware resource to larger systems. Customers who want to minimize power and cooling load in their data centers can use Vmotion to relocate workloads to more fully utilize particular systems or racks, a process that only takes seconds to execute and is fully scriptable – then power down the unneeded systems completely. When system usage rises again, the process can be reversed to ensure that demand is met.

Both IBM and VMware have made it their business to extend virtualization down into the SMB market. IBM has developed a set of tools that helps customers evaluate their existing infrastructure and how virtualization may impact costs, data center environmentals, and IT flexibility. The company has also, in conjunction with Intel and VMware, developed virtualization sizing guides that help customers solve the sometimes tricky task of selecting what to consolidate, where to put it, and how to configure their systems. IBM is also offering innovative financing programs that allow customers to tailor a custom package to fit their unique needs.

VMware is already building quite a reputation with SMBs; more than 850,000 copies of their free VMware Server product have been downloaded by small organizations worldwide. VMware is building on their popularity with SMBs by offering an inexpensive virtualization bundle that includes VMware Server and their VirtualCenter management and monitoring suite, which, including support, only costs $1,500. Quite a bargain, since this package can help an SMB get several servers' worth of work out of a single system, while at the same time reducing administrative and management workload.

GCG Recommendations

Virtualization is a technology that makes sense for data centers of any size and will begin to pay dividends almost immediately by allowing customers to get more bang for their IT buck. It has never been easier for SMBs to get on the virtualization bandwagon. For example, the IBM and VMware products and programs discussed above are specifically designed to help SMBs through every step of the virtualization process quickly, easily, and at low cost. A few years ago, we were telling clients to explore x86 virtualization, but to go slowly on implementation. As the technology has improved, our advice has changed. Now we tell clients that x86 virtualization is ready for prime time, and they should embrace the trend.

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