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THE ADVANCE OF VIRTUALIZATION PUTS THE FOCUS ON INFRASTRUCTURE NEEDS

Although virtualization has been around as a concept for a long time, it's only begun to proliferate in government as a result of mandates such as the Office of Management and Budget's Federal Data Center Consolidation Initiative (FDCCI), launched early in the Obama administration's first term. Budget pressures and other requirements, such as the need for agencies to boost teleworking, are now putting a focus on other technologies such as desktop and application virtualization.

It's early days yet, and the reported benefits of virtualization are still a matter for argument. In a recent article in FCW, for example, Mark Forman, former administrator for e-government and IT at OMB, called the projected benefits from server virtualization in agency data centers "smoke and mirrors." Savings of anywhere from \$2.4 billion to \$5 billion from data center closings will only happen if agencies also tackle the associated operational and management complexities, he said.

Nevertheless, the raw numbers are starting to stack up. By mid-November 2012, federal agencies had closed 382 data centers as a result of FDCCI and expected to close or consolidate about 1,200 of the 2,900 identified data centers by 2015. In a survey published early last year, MeriTalk found some 82 percent of federal agencies saying they had implemented server virtualization, and IT professionals expected virtualized workloads to almost double by the end of 2015. Most agencies also reported plans to implement at least some level of desktop virtualization.

Some agencies are being more aggressive than others. The Census Bureau, for example, instituted a "virtualization first" policy in 2011 that puts the onus on IT users to justify why their needs cannot be met through virtualization.

"It stipulates that all requests for servers be satisfied via a virtual guest as opposed to a discrete bare-metal solution," said Brian McGrath, the bureau's CIO. "That doesn't mean we virtualize everything, but we virtualize first unless there's a sound security or technical reason to justify us going with a traditional, discrete bare-metal server."

Nevertheless, he said, since the policy was put in place, Census has virtualized nearly 80 percent of all new Windows and Linux-based server builds.

Data sensitivity is what drives the decision to virtualize at NASA's Goddard Space Flight Center, according to CIO Adrian Gardner. If data is deemed too sensitive, then it's isolated on a physical server. But "in the grand scheme of things, virtualization has to be part of our core moving forward because we do want to reduce the footprint of our data centers but also increase capabilities while reducing the impact on our environment," he said.

In the one data center he has direct control over as CIO, Gardner said he's already virtualized about 80 percent of the servers and applications. Overall, the goal is to reduce the 13 data centers at Goddard down to two "hardened" centers — for the earth and science distributed data archive and for the supercomputer facility, and a virtualized center that will be moved into a containerized compute pod.

Ongoing budget pressures will only enhance the attraction of virtualization, Gardner added.

"I don't have a choice," he said. "If I stay the same course and make no changes, then I know my operations and maintenance tail is going to eat me alive, and virtualization is one of the tools we'll be using to handle the tight fiscal climate."

With the move to virtualization, however, come infrastructure issues that also need attention. Just as in

the physical environment, for example, security is also important in the virtualized environment and perhaps even more so because the opportunity for mischief is increased. An attacker can disrupt access to one application on a server in the physical world but has access to many others in the virtualized universe because many applications reside on a single machine.

“From a risk standpoint, in the virtual environment, I’ve got one machine that can be compromised that provides the key to the entire kingdom,” said Jim Smid, chief technology officer at Iron Bow Technologies. “I can do a lot of things with the entire enterprise through that one machine, so security becomes very important for the virtual infrastructure.”

Contention is also a major issue with virtualization. It relates to physical networks as well, of course, but those networks are designed to handle multiple, simultaneous communications. But virtual machines can be created almost on the fly, and many more of them can be sending requests and instructions back and forth across the network than the fixed, physical servers would. Those contention issues also tend to accumulate at the input/output of shared storage systems.

“I would say that the interaction of virtualized servers with storage is not well understood,” said Leena Joshi, senior director of solutions marketing at Splunk, a data management company. “When you virtualize servers, you actually mask the storage behind it. You could be attached to network-attached storage, iSCSI or Fibre Channel on the back end, and your virtual machines would not be able to tell what they are attached to.”

Those problems can be even greater with desktop virtualization because there are likely to be so many more virtual desktop images that have to be handled at any one time and that are making demands on the network and the storage systems. But unlike server virtualization, desktop virtualization is still new to government agencies and so the learning curve is still pretty steep.

“Server virtualization is much more well-known, and there are many more ways we know can work to add more capacity for that,” said Jose Padin, systems engineer manager at Citrix Systems. “It’s a known factor because the requirements of the servers are known. Once we learn what the requirements are for virtualized desktops, then matching the capacity to the needs will be

just as simple.”

However, it might be that the virtual world itself will also be getting more complex, which will ratchet up the level of understanding that’s needed to manage it. The current view of virtualization is to create a single, virtual platform that can provide different services to multiple users, but some see the need for a more diverse set of offerings.

“Right now you’ve got general-purpose virtualization for a general-purpose community of products, and that’s good for consolidation of low-utilization platforms,” said Peter Doolan, group vice president and chief technologist at Oracle Public Sector. “But then there are classes of applications as you move up the food chain that are more important, and that’s when you have to start looking at different types of virtualization.”

When you talk about virtualization now, you mostly think about hypervisors and a software layer that mimics a generic hardware substrate, he said. But in the future, as people begin to understand that there are various ways to solve their problems, you will start to see things such as virtualization of SQL itself, where SQL text can come from any machine.

“I think you are seeing that people realize that there’s not one ring that will rule them all and that there are different classes of virtualization starting to emerge,” Doolan said. “Virtualization will increasingly be seen as a portfolio of capabilities, and that will need people who understand how all the pieces come together.”

DESKTOP VIRTUALIZATION HAS ITS OWN INFRASTRUCTURE NEEDS

Although the focus of all agencies in the past several years has been on server virtualization and consolidation, virtual desktop infrastructure (VDI) has been seen as an obvious next step. For various reasons — lack of funds, doubts about security, concerns about increased complexity — VDI has not taken off as quickly as many assumed it would, though the need for cost savings and tangential trends such as bring your own device and teleworking are pushing it to the fore again.

In its survey of government IT professionals, MeriTalk found that a quarter of all federal agencies had plans to virtualize at least some of their applications, though only a small number expected to virtualize all applications for all their users. It also pointed out that, if VDI garners just half of the savings expected from server virtualization, agencies could cut nearly 10 percent from their IT budgets.

Cost is a big reason for the Census Bureau to go with VDI, both to minimize the cost of endpoint computing by using zero or thin clients and to centrally manage such things as maintaining and patching software, an expensive process at organizations with hundreds or thousands of individual desktop PCs.

Ironically, given the general doubts about security, Census CIO Brian McGrath believes another huge benefit of VDI is the boost it provides to security, particularly for the dispersed and mobile workforce the bureau employs.

“With VDI, we are providing the applications and data out of a private cloud, so the only thing the user sees is really just light that’s being pushed down the wire,” he said. “Since there’s no opportunity to store data on the endpoint, that ensures the security of that data and the applications.”

Security is also enhanced by providing the ability to

remotely kill an image on a mobile device, said Adrian Gardner, CIO at NASA’s Goddard Space Flight Center. He is looking to VDI to improve the way scientists at the center can collaborate with the many visiting scientists and students who contribute to NASA’s mission and who want to use their own devices to do so.

The biggest potential problem that affects performance with VDI is network latency, said Christopher Fudge, Census’ virtual infrastructure branch chief. Some of that is out of the bureau’s hands — if a worker in the Midwest can’t get a good mobile connection, for example — but some of the issues can be handled internally. Although not aimed wholly at VDI, Census has at the same time modernized its compute platform, rationalized its storage environment and upgraded its internal network capabilities to 10 gigabits/sec speeds as a part of an overall IT infrastructure transformation.

It’s a big mistake for an organization to assume that if it’s done server virtualization, then it knows what’s needed for desktop virtualization, said Jose Padin, systems engineer manager at Citrix Systems.

“Server and desktop have a hypervisor in common and not much more,” he said. “With server virtualization, it’s a server providing a service that users access through a browser, and they don’t generally have to log on to the server. With desktop virtualization, the desktop Windows operating system is running on the back-end infrastructure and being remotely controlled, and because of that the requirements for RAM, CPU and storage are vastly different.”

Also, he said, although VDI has obvious advantages for supporting the increasing numbers and kinds of devices being used in organizations today, there are other ways to virtualize the desktop, such as sharing a single operating system running on a server with many different users, something that could be used as

a stepping-stone to full VDI. The key is knowing what users are actually doing in their daily business and what their specific requirements are.

That also points to the network latency issues that will crop up. You can't assume that desktop virtualization will only run in large-bandwidth and low-latency scenarios, he said, so you have to plan for situations where you won't have those things to deliver a truly great virtual desktop solution.

IF YOU WANT VIRTUALIZATION SUCCESS, LOOK TO STORAGE

Storage presents an interesting conundrum for agency IT managers when it comes to virtualization. Because the characteristics of networks, servers and client systems in the physical infrastructure are well understood, matching storage up with requirements has become a relatively mundane exercise. Not so in the virtualized infrastructure.

“Storage is still the Achilles’ heel for any virtualization solution,” said Paul Schaapman, a solutions architect at CDW-G. “If you don’t design it properly, with the right amount of [input/output operations per second] built in to match the demand of the server groups that are going to be put online, then you will get in trouble.”

Initially, people building virtualized environments didn’t bring IOPS into their considerations, he said. But they now realize that, as you lay down virtual machines on top of targeted local-area networks, you’ve got to make sure that they are optimized for the storage that’s going to be needed.

“Peak demand is what you are really architecting for,” Schaapman said.

The problem for agencies that are virtualizing is that, as they go through data center consolidations and provide shared services across jurisdictions, they start getting different types of workloads that normally would have had their own resources dedicated to them that are now competing for access to those same shared services, said Augie Gonzales, director of product marketing at DataCore Software.

What that does is produce very different behaviors from those found in the physical environment, with requests for resources colliding with one another in a way that’s completely different from what classical design criteria would lead you to expect.

“With those, you would isolate the workloads and be able to dial in exactly what was needed for them and

not have to worry about all the other noise,” Gonzales said. “In the virtual and consolidated world, the sandbox is exposed, and there are no walls to stop one thing from encroaching on something else in the sense of I/O requests and how quickly these get to shared disks.”

This is forcing a turnaround in thinking among IT professionals. Several years ago, they had what Gonzales called a naive approach to architecting storage as the last effort in putting a solution together. They felt they could simply plug in whatever capacity was needed, at the lowest cost.

“But they’ve been surprised how much storage has to do with speed and how fast responses are in the virtualized environment and what it means to the reliability of results,” he said. “So they’ve learned that part of the transition from the physical to the virtual world is that success is driven by what kind of shared storage infrastructure you put together for both environments as you are cutting over.”

It comes back to the issue of avoiding contentions, and that comes down to the key areas of how much network bandwidth is available, how much CPU power is available, the size of the cache and storage I/O. Make sure you know what applications are being put into the infrastructure and how users access them, and then make sure you’ve got enough resources available to handle the peaks in demand.

That will become even more important as the number of virtual desktops increases. At certain times during the day — for example, in the early morning — a large number of people will “boot up” their virtual desktops all at once, causing a rush of requests to the servers that provide their desktop images. Get that wrong, and you’ll have a bunch of angry users flooding IT with complaints about not being able to get their work done.

“If the storage layer and application layer are

ignorant of the virtualization technology, the [storage-area network] or [network-attached storage] array or whatever storage you are riding on top of becomes the critical bottleneck,” said Peter Doolan, group vice president and chief technologist at Oracle Public Sector. “The virtualization layer has no clue why that I/O is coming in. All it knows is that some [application programming interface] has been called that mimics an I/O to a disk drive, which means that the customer has to compensate for that architectural weakness by having a highly efficient I/O subsystem that can take into account the [virtual machine] broadcast storms.”

The way you mitigate those I/O storms in virtual environments is to engineer around the problem, he said, “by having the biggest I/O pipe possible to your I/O subsystem.”

Another form of virtualization also comes into play with all this, which is virtualization of the storage itself. Most organizations will have the physical storage needed to handle their virtualization needs, but in order to make it fully capable of addressing those needs, it will also have to be virtualized. That’s done through the use of a storage hypervisor, which, like the server and desktop equivalent, is software that brings together an organization’s storage assets under a central administration that then parcels out capacity as required.

This all adds up to an increasingly complex environment that can be tough to manage to make sure that end-user performance doesn’t degrade. It’s important for administrators of a virtualized environment not to get too attached to just one part of it, said Leena Joshi, senior director of solutions marketing at Splunk.

“If you only look at the virtualization layer metrics, then you are probably looking at some metrics that are incorrect,” she said.

If you want to know how much memory is being used by each virtual machine and you are only looking at what the hypervisor is telling you, she said, then it will be an incomplete picture because the hypervisor won’t count things such as cache memory. If you are running an application that is a very heavy resource user, such as a database, the cache memory of the database is not included in the active memory reported by the

hypervisor, “and then the virtualization administrator and the owner of the application will be at loggerheads.”

“The application owner thinks he doesn’t have enough memory, and the virtualization manager says, ‘You guys are conning me. I gave you so much memory, and you’re not using it,’” she said. “So you can’t just look at it as a silo problem or just one of the virtualization layer. You have to look at the operating system metrics, the application logs, the underlying storage, the underlying network metrics and so on, and then you need something that can pull all of that together.”

Depending on how you look at those things, storage and storage virtualization could take care of a lot of the performance problems in the virtualized infrastructure. According to that theory, because the applications and workloads operate within virtual machines and are moved from one physical server to another through the storage mechanism, the virtualized storage infrastructure becomes the traffic cop for those cutovers from one machine to another.

“Anything that has to do with dynamic resource scheduling, with failover, with live migrations between environments and so on, that’s all mediated by the storage virtualization layer,” Gonzales said. “That, again, points to storage being the central influence on the outcome of an organization’s virtualization efforts.”

IT SKILLS NEEDED FOR VIRTUALIZATION ARE FAMILIAR BUT DIFFERENT

When it comes to the people and skills needed to build a virtualized infrastructure, it's tempting, because this is still about technology, to think that current skills in the IT department will suffice, though perhaps with a little tweaking. On one level, that might be right, but organizations realize that it will take much more than traditional skills.

Adrian Gardner, CIO at NASA's Goddard Space Flight Center, thinks there will definitely be a variety of different skill sets needed from a variety of people — certainly those who understand the technology but also those who can work with the span of stakeholders who will be affected by and will regularly use the virtualized infrastructure.

"It's going to be staged around those people who understand the cloud and virtualization for sure, and there'll be a big upswing around security," he said. "But we'll also be preparing the user base and our colleagues who actually run projects and programs to incorporate virtualization and cloud infrastructures on the front end of the conversation for things they are planning to build five to 10 years out."

To do that, he's established an "innovation program" in which the people who operate the day-to-day side of Goddard's current physical IT infrastructure join an innovation team that is looking at what's

needed for virtualization, creating what he terms an "operations-to-innovation life cycle."

"We'll innovate on one side and then have what amounts to a sandbox where the innovators and the day-to-day infrastructure engineers can have a mind meld and share ideas back and forth as well as competencies," he said. "We'll also be bringing in the user base, so both the operators and innovators can hear from the users and what their demands are."

The idea is to bring the overall workforce up to speed in its competency about virtualization as well as the cloud, he said.

The specific technical skills needed to manage the virtualized infrastructure likely already exist in the IT department, said Jose Padin, systems engineer manager at Citrix Systems, but might have to be applied in a different way than people are used to. As opposed to server virtualization, for example, those handling virtual desktops will certainly need Windows operating system management experience, but they'll also be involved in direct user contact.

Likewise, Windows Server operating system management skills will be needed, so those people used to managing Microsoft enterprise systems will also need to handle the virtual infrastructure components.

"There will be a learning curve to understand the technology, the many to one, but the skill sets for this do exist," Padin said.

Oracle Public Sector Chief Technologist Peter Doolan, however, thinks a central virtualization architect who can understand how all the pieces in the virtualized infrastructure come together might be needed.

"We have managed to execute the mission of IT in the physical world because we have visibility into it and because much of that infrastructure is siloed," he said. "But you virtualize that and you've lost that human line of sight to the problem, and that means you have to have a much tighter role around architecture, around communicating that architecture, and with the governance to make sure that works within your skill sets and the team you have on the ground."

Doolan said he loves technology and all the things associated with it, "but I have never seen a technology [such as virtualization] turn around and bite its owners so hard." He worries that the IT leadership in government thinks this is the one thing to cure everything.

"It's not," he said. "It's down to the human side of it and how people are accepting this and managing it. Technology has always needed time to gestate."

THE BENEFITS FOR VIRTUALIZATION ARE OBVIOUS BUT STILL NEED TO BE SOLD

Government agencies have never been so flush with cash that they could implement new IT programs at will. In the current era of severe budget constraints, developing and launching virtualization projects require even closer attention to return on investment and an ability by the executives in charge to argue the value content of those programs.

That's true even though agencies have begun to realize significant savings through the server virtualization and data center consolidations they've already achieved. Even then, however, finding ways to pay for ongoing and new virtualization programs isn't easy. In its survey of government IT professionals, MeriTalk found that more than one-third of respondents quoted the capital costs involved as one of the major pressures on server virtualization, with even more also saying they didn't have the funds to migrate legacy applications to the new environments.

The truth, as many government IT leaders will tell you, is that agencies have to invest in order to achieve the kinds of efficiencies in their operations that both administration and congressional authorities are constantly demanding from them. Virtualization, with its inherent promise of being able to do more with the technology that's available, is an option whose attraction is increasingly obvious.

That was the reason behind CIO Adrian Gardner's push for virtual desktop infrastructure (VDI) at NASA's Goddard Space Flight Center, for example. The threat that his operations and maintenance tail would "eat me alive" forced him to choose virtualization as a primary tool to handle that in a tight fiscal climate.

Even so, he said, he still had to make a hard sell to his chief financial officer and other management that it was the right thing to do. In the end, he focused on relatively proven factors of improved performance and

the potential cost savings.

"We've been able to tell the story that, if we invest in virtualization and VDI, then some of these innovative practices and capabilities will yield an ROI," Gardner said. "We're also beginning to prove out that those investments will result directly in cheaper new buildings and reduced construction and maintenance costs associated with the facilities we already maintain."

Those kinds of arguments centered on localized returns tend to make a bigger impact than projections of overall efficiencies, he said.

Dwindling budgets are also a firm reality at the Census Bureau, according to CIO Brian McGrath, "but at the same time, my customers are not coming to me and saying it's OK for me to do less. It's exactly the opposite."

However, there's a real understanding in his organization about the need to move to enterprise common services, and that's what VDI is expected to provide. It's really the only way to deliver the emerging capabilities that his customers need in order to deliver the daily analytics and data capture requirements of the bureau, he said.

The much faster speed to market to support the expansion of telework was also something that executives at the bureau quickly understood.

"From a VDI perspective, we've got something on the order of 2,500 people who are teleworking now," McGrath said. "Having the opportunity to do that with personally owned equipment [eliminates the] millions of dollars and delayed adoption of telework if we had to go through the process of issuing everyone a laptop."

The bureau also has a hard target with the next decennial census in 2020, for which it will need to support a large field organization. Virtualization is seen

as the focus for the IT that field organization will employ.

“VDI really positions us well for that since, in the charter we’ve built for the project, we said that the architecture shall have the capability to scale to a million users,” McGrath said. ●



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