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WHITE PAPER

End-to-End Virtualization: A Holistic Approach for a Dynamic Environment

Sponsored by: IBM

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EXECUTIVE SUMMARY

Server virtualization is a decades-old technology that is now extremely mature and part of the fabric of Unix, mainframe, and RISC servers. Virtualization began to be used on x86 servers in 2003, mainly for test and development, and has evolved rapidly since then. By 2007, the second generation, Virtualization 2.0, was under way, and the focus was consolidating production applications. Today, we are transitioning to the third era of virtualization deployment (3.0), which is taking on cloud-like attributes for highly virtualized and automatically managed internal deployments. The transition to adopting cloud-like deployments shifts the focus from early capex savings drivers to transforming IT into a service and delivering operational efficiencies.

Virtualization 3.0 expands virtualization beyond just hypervisors and servers. Server virtualization has been the catalyst for the 3.0 era, and it has driven transformation into every aspect of the datacenter, such as storage, networking, and management. The virtualization of all aspects of the datacenter, not just compute, will create the foundation for the cloud model of computing. Achieving this requires a holistic approach to virtualization and the ongoing management in order to create a unified, dynamic, and agile next-generation computing environment that includes:

- A fully virtualized datacenter spanning compute, storage, and networking
- Comprehensive management that can see through multiple abstraction layers, cross datacenter disciplines, automate tasks, and span physical locations and cloud
- Hybrid clouds that seamlessly link internal and external resources

The benefits of such change will be many:

- Increased business agility by having IT be able to respond instantly to changing business needs
- Improved service levels, with users able to self-provision instantaneously as needed
- New cost models and flexible sourcing options

This IDC white paper also includes two case studies highlighting the experiences of a service provider and a large enterprise as they begin to implement server virtualization and progress toward a Virtualization 3.0 cloud goal.

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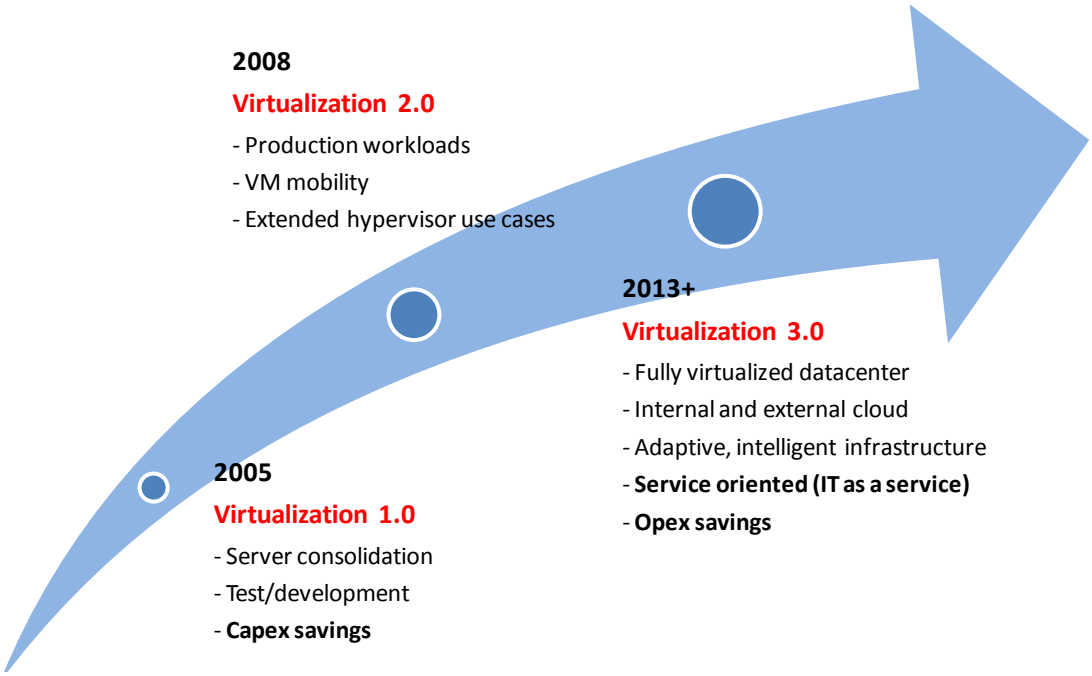
SITUATION OVERVIEW

Figure 1 provides an overview of virtualization maturity.

FIGURE 1

Virtualization Maturity Overview



Source: IDC, 2011

Since its emergence in the early 2000s, virtual machine software technology aboard x86 servers has quickly become one of the most disruptive technologies in IT infrastructure. Outside the x86 world, virtualization has existed for many decades, becoming an inherent part of these hardware architectures and operating systems. x86 server deployments, however, were typically single workload, resulting in large clusters of resources that were minimally utilized. The ability to virtualize these servers and reclaim excess capacity caught the interest of datacenter managers who sought to reduce capital spending and faced difficult power, cooling, and space problems.

The first phase of customer adoption of server virtualization, the 1.0 era, began in 2003. About 70% of all virtualization software deployments in 2003 were related to software development and testing — using hypervisors inside an organization's test and development labs for consolidation purposes.

But by the end of 2005, IDC saw the spending shift from consolidating software development and testing environments toward organizations trying to consolidate applications within the production part of the IT infrastructure as IT managers became more familiar with and confident of the hypervisor's ability to handle enterprise workloads (the 2.0 era). Static consolidation was still the primary use case, and enterprises realized huge capex savings from it.

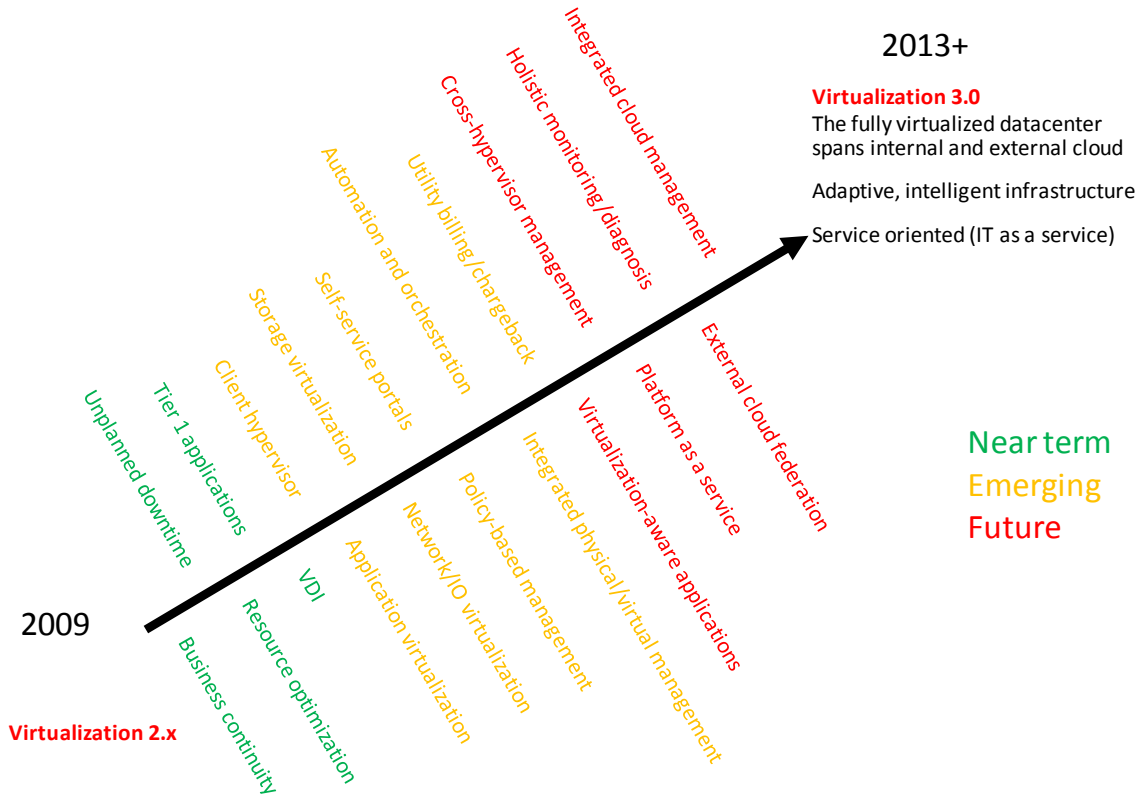
Since then, the industry has continued to focus more heavily on production-level consolidation, which today continues to be a primary motivator for customers to bring virtualization within their organizations. With production-level virtualization well proven in the industry, we now begin the march to the 3.0 era of virtualization, which is synonymous with cloud-like virtualized infrastructure. IDC believes that as we exit 2.0, there will be a multitude of intermediate steps (2.x steps, if you will) that will culminate in Virtualization 3.0. These steps will go well beyond just consolidation to deliver new benefits from virtualization.

Virtualization 3.0 is really about a fully virtualized (servers, storage, networking), autonomously managed, and scalable infrastructure, what many call the dynamic datacenter delivered as a service (IT as a service) or simply cloud. Clouds can be internal and external (physical location), private or public (access method), or hybrid (a combination of internal, external, private, and public).

To get to Virtualization 3.0, however, enterprises must go through a series of intermediate 2.x milestones. IDC has divided the milestones into three categories: near term, emerging, and future. Enterprises may adopt the items in different orders and at different times, but the conglomeration of these milestones will make up Virtualization 3.0 (see Figure 2).

FIGURE 2

The Long Road to Virtualization 3.0



Source: IDC, 2011

FUTURE OUTLOOK

Getting to Virtualization 3.0 requires a more holistic approach to virtualization. Virtualization is no longer just a standalone consolidation tool but an integral foundation for the datacenter that changes everything it connects to and requires end-to-end management (from the physical layer up to the application layer). The focus moves from the hypervisor to the entire platform that the hypervisor enables, including storage, networking, and a full management layer that can correlate across disciplines and up and down the software stack.

Virtualization 3.0 affects every datacenter decision:

- **Storage.** Storage has been the area most impacted by server virtualization. Advanced virtualization requires shared storage, which can bring savings from consolidation of storage (moving to shared, networked storage from direct attached), but also many challenges. Keeping up with capacity for virtual machines (VMs) has been a challenge for many. Going forward, storage infrastructure must also be revamped to match the changes and support the growing virtual environment. Virtualization introduces fundamental new paradigms that change how nearly all storage functions work, such as backup, recovery, and offsite disaster recovery. The I/O paths and the I/O patterns of a hypervisor host are now completely different, in both software and hardware, and new connectivity schemes such as Fibre Channel over Ethernet (FCoE) are emerging as well. Various forms of storage virtualization (including cloud storage) are also key to providing abstraction and pooling benefits similar to those delivered by server virtualization to allow data to be as mobile and available as VMs.

- **Networking.** As virtualization deployments became more advanced, customers began to leverage the dynamic features that VMs can bring, such as on-the-fly migration. This quickly began to show weaknesses in the traditional networking infrastructure, which was built for static topologies. New architectures such as fabric-based topologies and network virtualization will help remove the current restrictions on where and how far VMs can move and will route the corresponding traffic much more efficiently to enable more agility and remove location and distance barriers. In addition, network convergence standards (such as VNTag, FCoE, iSCSI, and DCE) will simplify the network and connections, both in the core and at the endpoint.

- **Automation.** Virtualization has created an explosion of virtual servers that has exceeded anyone's best estimates. The number of managed objects (the VMs themselves and the objects within them such as the operating system and application) is growing to an unprecedented level and, combined with the dynamic nature of VMs, creates a constantly changing infrastructure requiring new standards such as OVF and RESTful to facilitate VM workload mobility. At this scale, manual processes simply break down and are too slow in a cloud world. Much of what is done manually today simply must be automated in order to manage it at all and provide the speed that users demand. Automation is also attractive in that it can bring consistent execution of IT in accordance with governance and regulatory IT standards that many must abide by. This will require not only software management technology but IT process change as well.

While automation is a necessity simply because of the scale, it will also bring more intelligence to the datacenter, allowing it to quickly react to events that would prove disruptive today, such as an unexpected load spike.

- **Holistic datacenter management.** Today's datacenters are siloed with pools of servers, storage, and networking that are largely individually managed by different teams. Adding to this complexity is virtualization, which abstracts much of the infrastructure, making it more difficult to look inside the engine when things go wrong. Virtualization itself often becomes its own silo (or silos if using multiple hypervisors), which can be difficult to break out of without an overarching management platform. As the level of abstraction and interconnection grows, a more holistic approach to management and monitoring is needed. Most of the virtualization management market today is focused on resource management and change and configuration. There is little correlation to the physical underpinnings and to the applications running inside the VM. In addition, information is difficult to correlate across the disciplines (storage, compute, network, security, etc.). Virtualization 3.0 will require a new approach, where we can understand what application is inside a VM and correlate that application service to the entire infrastructure that it may rely on (hypervisors, physical servers, storage, networks, etc.). Without this holistic view in a cloud architecture, troubleshooting becomes a search for a needle in a haystack, and proactive monitoring and response becomes nearly impossible.

- **Hybrid clouds.** Cloud models are permeating every aspect of IT, from the private clouds being built on premises to the myriad of public cloud services being built by service providers. The debate rages on about what will be moved to the public cloud — and how and when — but the fact is that both private and public cloud models will certainly compose the next generation of IT, whatever its final makeup. This hybrid cloud model will require a higher level of linkage between on-premises and off-premises clouds to be truly utilized as an enterprise resource. This linkage is composed of several areas, all of which are being developed rapidly today:

  - A format and mechanism for moving workloads to the external cloud and back from the cloud

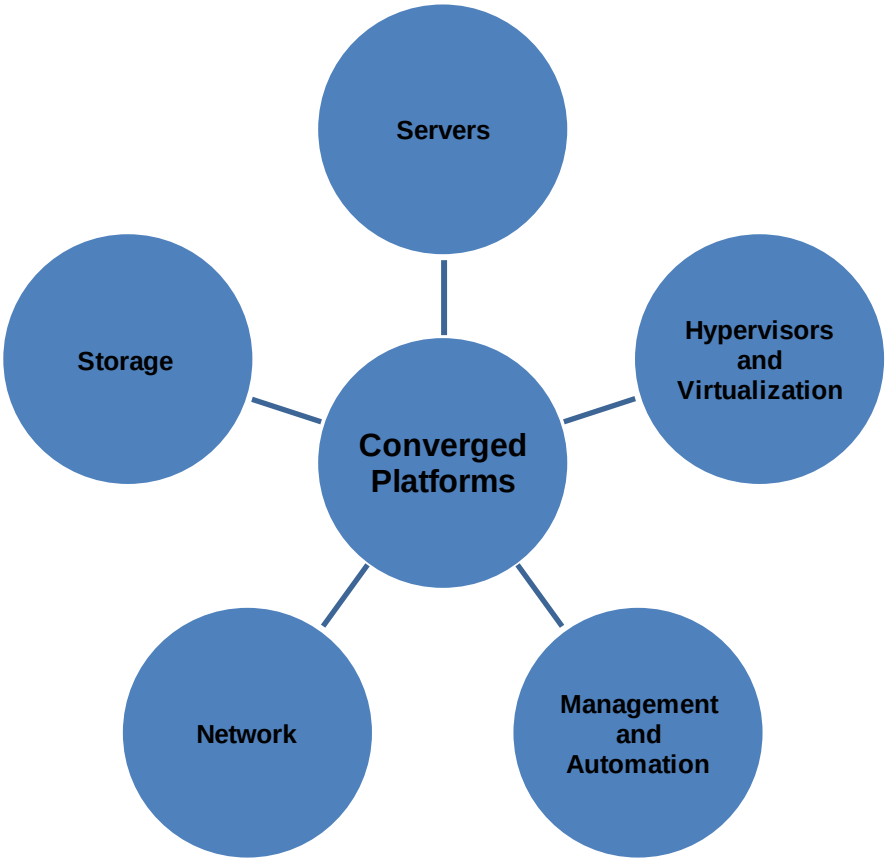
  - Standardized management interfaces to allow a single set of tools to manage both on-premises and off-premises resources

  - Federation between clouds and end-to-end security to protect a company's assets, regardless of where that data may reside

Figure 3 provides an overview of the holistic approach to virtualization.

FIGURE 3

Holistic Virtualization



Source: IDC, 2011

Server virtualization is a catalyst that will drive change into every part of the datacenter. Cloud, a natural extension of virtualization, also brings a completely new delivery and service model. Together, both technologies offer disruptive new benefits, but they also will impact every aspect of IT, and careful consideration of the impacts on all these areas will be key to a successful deployment and reaching the Virtualization 3.0 goal.

IBM PROFILE

IBM is one of the largest industry leaders in IT technology, spanning hardware, software, and services. It has long been a leader in virtualization, beginning with System z decades ago, and now across multiple platforms and systems. As enterprises embark on the journey to Virtualization 3.0, IBM has developed specific

programs to guide customers through all the steps and milestones to achieve an agile, dynamic cloud.

Customers initially deploying virtualization are generally looking to consolidate to improve the efficiency and the utilization of their IT resources. On the non-x86 side, IBM has the POWER and System z servers, with a long history of virtualization built into the hardware and system software. For x86 systems, IBM offers System x servers that have been designed for virtualization, and customers can choose any of the industry x86 hypervisors, such as VMware, Hyper-V, Xen, or KVM. For the actual migration from physical to virtual, IBM Global Services helps customers assess and plan with advanced discovery and analytic software that takes configuration information, performance data, business attributes, and utilization patterns to create a map of which workloads should be prioritized for maximum efficiency, the placement and allocation of the VM, and the risk associated with virtualizing.

Virtualization 3.0 is more than just server virtualization; storage and networking infrastructure must be addressed as well. Storage and networking virtualization implementations are also available from IBM to bring both areas benefits that are similar to those that virtualization brought to servers. These benefits include better utilization, higher efficiency, and similar savings on power and real estate. This holistic approach also lays the groundwork to create the fully virtualized datacenter, where resources can be allocated and moved at will, and abstraction of physical storage and network details is the first step in achieving that.

After consolidating workloads, customers must now turn to the operational side and address the management of the physical and virtual resources in this new environment. Management of workloads is the foundational base that first must be addressed. IBM provides cross-platform management solutions that address x86 and non-x86 systems, multihypervisors, and even non-IBM systems with a "single pane of glass" to help improve IT staff productivity. IBM addresses several key issues with its workload management solutions:

- Improve staff productivity to scale operations
- Compliance with business policies to include improved resource utilization with ongoing capacity planning and management
- Address the complexity and interdependencies created by growth of the virtual environment
- Simplification of the environment and integration of the management of all resources

The next level of business agility comes with automating processes. Automated processes are virtually mandated by Virtualization 3.0 as the scale and speed of operations will cause manual processes to break down or not be able to respond fast enough. IBM works with customers to define business priorities, processes, regulatory compliance, and SLAs, which will define policies that will allow systems management software such as Tivoli to automatically respond to changing business conditions. Infrastructure becomes more dynamic, sensing and responding to changing workload requirements by moving workloads to the best-fit infrastructure.

Virtualization management becomes integrated with the IT processes that support business priorities.

The final step on the journey to Virtualization 3.0 is to take this newly created, dynamic, smart infrastructure and deliver it as a cloud service. On the user-facing side, IBM assists customers in the creation of self-service portals, allowing users to provision as needed. IBM Global Services also consults with clients in the transformation of IT into a services-oriented center that includes:

- Elastic scaling to meet demand
- Pay-as-you-go, utility-type billing
- Business-driven service management with Tivoli service management technologies
- Implementation of service catalogs
- Global, always-on availability

IBM is one of the few vendors that possess the assets to deliver turnkey cloud solutions. IBM offers CloudBurst for compute clouds, SONAS for storage clouds, and IBM Service Delivery Manager (ISDM), an integrated software stack for managing clouds.

IBM also strategizes with customers about leveraging external clouds, private or public, which are key to realizing Virtualization 3.0 where enterprise computing is not bound by physical barriers or location. IBM works with customers to identify workloads that are ideal for public cloud, assess the risk, and assist in the actual migration. To ease the management and create a smooth interface, a hybrid cloud that links internal and external resources can be implemented. IBM Global Services has developed the experience and methodologies to work with customers to successfully adopt cloud, as well as hosting several clouds of its own.

Wherever customers are on the journey to Virtualization 3.0, whether they are just starting basic consolidation through virtualization or they are building hybrid clouds, IBM can provide the hardware, software, and services to lead customers through every step of that journey.

CHALLENGES/OPPORTUNITIES

Challenges

- **Avoiding VM stall.** Customers often get to a certain point in virtualization (generally about 30%) and then find that scaling further becomes difficult. Stall can happen for many reasons, including storage infrastructure problems and VM sprawl problems. Taking a more holistic view of virtualization and realizing and planning for the massive change that virtualization will bring to every aspect of the datacenter are the keys to avoiding stall.

- **Application certification.** While progress has been made, not all application suites, especially older versions on x86, and applications from smaller ISVs have been certified for a virtualized deployment. Customers relying on this level of assurance are being limited in their effort to virtualize the installed base.
- **People and process.** While technology progresses at an astounding rate, people and their processes are often much more difficult to change and can hold back the potential of a new technology such as virtualization or cloud.
- **Technical complexity.** A cloud is a highly complex amalgamation of IT hardware and software with many problems still to be solved, such as security and linking clouds. There are sure to be hard lessons learned in the areas of software coding, architecture, management, and deployment as the industry progresses toward Virtualization 3.0.

Opportunities

- **Reduced cost.** Building more automation and intelligence into datacenters will lead to unprecedented levels of efficiency, bringing both capex and opex savings to customers. IT can scale operations and improve service to unprecedented levels while making the most out of physical assets and operational staff.
- **Improved service levels.** Smart infrastructure that understands the requirements of each specific workload and that can adjust dynamically to meet them will result in higher service levels for users.
- **IT and business agility.** A fully virtualized and dynamic infrastructure will bring new agility and speed to users, allowing computing to keep up with the needs of an ever faster changing business environment.
- **Flexible sourcing.** Virtualization and cloud computing can offer customers faster and more flexible sourcing of computing resources to meet different requirement and workload peaks. IDC anticipates that most companies will use a hybrid model, buying different functionalities (IaaS, PaaS, SaaS) and using a variety of deployment models (private, public, internal, and external).

CONCLUSION

The transition from Virtualization 1.0 to Virtualization 2.0 was simply a move from test/development to production. The transition from Virtualization 2.0 to Virtualization 3.0 will be much longer, but with the potential for much greater reward, with the goal of transforming the entire datacenter and moving IT from a wiring closet approach to a cloud services model. Server virtualization has already delivered tremendous capex savings, and Virtualization 3.0 will begin to deliver opex savings as datacenters reach unprecedented levels of efficiency and service delivery. Virtualization 3.0 is being driven by server virtualization, but it is much more than that. The bigger picture is end-to-end virtualization, a holistic approach to the datacenter transformation to cloud, and a more dynamic and agile environment. There will be many milestones as the industry transitions from 2.0 to 3.0. The journey may take many years, but the payoff will be dramatic.

Star Technology Services

Situation Overview

Star Technology Services is a United Kingdom–based managed services provider, offering connectivity, hosting, security, and software-as-a-service products. With its original roots as an ISP and hoster, Star has embarked upon a transformation to become a cloud service company, leveraging virtualization and advanced management technologies.

Star currently has about 250 total employees, with 60 employees serving in an IT role. It operates approximately 1,200 physical servers, which are spread across three datacenters in Gloucester, London, and Bristol. Like many enterprises, Star has implemented virtualization (using VMware's hypervisor) to consolidate its internal servers and save on hardware, power, cooling, and real estate costs. Star uses IBM's Tivoli products to manage its infrastructure, and the Tivoli development environment has been consolidated with virtualization, which also help speeds testing and time to production.

But the primary goal for any technology for Star is how to use it to create innovative new products and services for its customers to gain a competitive edge against other providers. Star was looking to use virtualization as the foundation for two new cloud offerings:

- **vChassis.** A virtual server that runs on Star's multitenant, shared infrastructure cloud
- **vPlatform.** Dedicated hardware for a single customer running in a VMware cluster configuration, essentially a small private cloud (Customers buy the cluster and are free to create and move VMs and manage the VMs as they wish, with Star managing the underlying virtual infrastructure.)

The Solution

Before virtualizing, Star had to strengthen its storage and networking infrastructure. Virtualization is known to put more pressure on networked storage systems, and Star wanted to ensure that the SAN would be able to keep up with the added load. Star rearchitected its SAN to be able to scale capacity on short notice as it added customers. On the network side, Star implements VLANs using custom-built tools to separate and secure customer traffic, and that system had to be revised to accommodate the blade server switch and the virtual environment.

One key area for success of any virtualization deployment is management. Star has been a longtime partner of IBM, leveraging IBM's Tivoli service management products to manage its infrastructure. While VMware has its own tools to manage its virtualization platform, which Star also uses, Tivoli was still the primary platform for overall cloud service management. Support for virtualization and integration with VMware by IBM was key to Star's cloud buildout. Star initially chose Tivoli for its scalability and proven reliability. Scale is essential for a provider of Star's size, and Star wanted the ability to grow without having to exponentially increase operational staff. Tivoli also has a long track record of reliability, allowing Star to automate tasks

and consolidate management in one place with confidence. With virtualization, Tivoli was extended into the virtual realm, allowing Star to further recognize its investment in the Tivoli platform. The integration with VMware allows Tivoli to manage the intersection of the virtual world with the physical server, storage, and networking, as well as within the VM, to manage the operating system and application.

Benefits Realized

Star currently has hypervisors installed aboard approximately 15% of its physical servers. Star's customers run a mix of operating systems — about 80% Windows, 15% Linux, and 5% Solaris. Most of the workloads being virtualized are the Web and application server tier for customer-facing ecommerce sites. Most of the back-end databases are not virtualized yet, simply due to their scale and size, and Star's customers have been more reluctant to virtualize the back-end infrastructure. Some of the benefits Star has gained from its virtualization deployment are:

- **Lower cost per server.** A virtual server is cheaper than a physical server due to hardware savings, power and cooling savings, and real estate savings. Star is able to offer customers a virtual server at about one-third the cost of a physical server and is seeing consolidation ratios of about 10:1.
- **Better customer experience and faster service.** A virtual server can be provisioned nearly instantaneously for customers, which isn't possible with a physical server. In the emerging cloud market, customers expect instant gratification, and virtualization is key in enabling that.
- **Improved availability and service levels.** With physical servers, Star would have to locate a spare machine and then restore everything from backup if something went down. With virtual servers, software can use vMotion or restart a VM on another server. Monitoring and load balancing software can also dynamically relocate workloads so that customers always get the resources their applications need.
- **Scalable, dynamic infrastructure.** This foundation gives Star the ability to scale the cloud without having to exponentially build out infrastructure or increase operational costs. Star currently has scaled to 2,000 logical servers in its cloud, adding only 200 physical servers and avoiding an increase in operational staff. This allows Star to react quickly to the fast-changing cloud provider market and business needs.
- **Holistic, end-to-end view of the datacenter.** Using virtualization and comprehensive Tivoli management tools, Star is able to gain deeper insights throughout the entire datacenter and across servers, storage, and networks to build an overall view of its services.

Future Outlook

For the future, Star is looking to add several key features to its cloud and address some challenging problems:

- **Capacity monitoring and planning.** As a service provider, Star has different virtualization needs than an enterprise, where there is a fixed number of servers and a target of what to consolidate. Star uses virtualization to create a product,

and as an infrastructure provider, it doesn't want to have large amounts of infrastructure sitting around idle, waiting for customers, but it also doesn't want to run out of capacity and not be able to sell something when a customer needs it. It's a fine line to walk, and Star is looking for capacity management tools to manage it.

- **Multitenancy.** One issue that Star faces as a service provider is that most management products are built for a single enterprise, which assumes a single customer. Star has a large infrastructure that is carved into many smaller ones, each dedicated to a different customer, and it finds that many management products do not account well for this scenario. While today Star has a very good view of its overall infrastructure, the challenge is to turn that into customer-specific views. Star would like to eventually create a customer dashboard, where customers can see and manage their own provisioned slice of the cloud.
- **Self-service portal.** A customer self-service portal is rapidly becoming a must-have feature for any cloud, and Star is no exception. Building such a portal is currently very high on Star's priority list.
- **Hybrid cloud.** As the cloud market gains momentum, Star sees the need to address the hybrid model that will inevitably arise. Star's customers will have their own internal private clouds, services from Star, as well as services from other cloud providers. Star anticipates that as customers source more and more from external cloud providers, they will have to better integrate their infrastructure with their customers'. For the customers that source primarily from Star for IT, the provider anticipates that they will look to Star to be the primary management interface and services monitor. Therefore, Star will have to integrate with a variety of other cloud services and allow customers to manage all their environments in one place.

Unilever

Situation Overview

Unilever is a multinational corporation producing home, personal care, and food products under a variety of brands, such as Knorr, Hellmann's, Lipton, Dove, Vaseline, Persil, Cif, Marmite and Pot Noodle. The company has approximately 167,000 employees in over 100 countries. To serve such a large employee base, Unilever has approximately 10,000 physical servers, which are split between two datacenters in different parts of the world. One datacenter is insourced and managed by Unilever IT staff. The other is outsourced to a third-party provider. Unilever began to consider virtualizing its servers about six or seven years ago. At that time, several larger corporate initiatives were under way, which helped drive a lot of the interest in what virtualization could do for the company. These initiatives were:

- **Massive business change.** Unilever undertook a massive corporate initiative to simplify and unify the company's operating structure. IT had supply systems to support all this change. Paulo De Sa, vice president of Global IT, Infrastructure Services, explained, "The exact dimensions of the change were not always clear at the outset as far as business plans translating into computing needs, so we needed to become a lot more agile."

- **Reducing costs.** IT was under a lot of pressure to reduce the cost of computing. Unilever was facing rising energy costs and datacenter space constraints and thus had to embark on various consolidation projects, both inter- and intra-datacenter.

- **Sustainability.** Sustainability is very high on Unilever's agenda and a key corporate value. Out of this theme arose a green IT program, which helped spur interest in technologies, such as virtualization, that could assist in decommissioning servers and raising utilization rates. It also brought in collaboration tools such as videoconferencing to cut down on corporate travel.

The Solution

Facing these driving factors, Unilever began to virtualize its servers, using VMware and Hyper-V on its x86 servers and IBM PowerVM virtualization technology for its Unix servers.

Storage infrastructure is a critical support system that is highly impacted by virtualization. Unilever had already begun a separate project to consolidate and strengthen its SAN infrastructure, so by the time the virtualization projects began, the underlying storage-attach infrastructure could more than handle the new environment. In another move to transition to a fully virtualized and cloud-like datacenter, Unilever recognized very early the value of virtualizing its storage with a variety of technologies. Initially scale and size was a problem, but with IBM's help, that was overcome, and today multiple petabytes of capacity run virtualized. Virtualizing the storage gave Unilever the ability to more quickly allocate storage due to unforeseen spikes, implement disaster recovery between datacenters, and run production in alternative locations if need be.

Support from application vendors and application owners within the company was often a stumbling block for virtualization deployments, but Unilever ran into few problems in this area. Before virtualization began, infrastructure and applications were already decoupled at Unilever, a move that happened more than 10 years ago. The application team specified requirements for its application, and the infrastructure team then decided how to support that. With that level of abstraction already in place, Unilever avoided the typical negotiation, fears, and doubt as application owners had their infrastructure virtualized. In addition, VM sprawl, a common side effect of virtualization, was never a problem at Unilever thanks to strong existing processes around provisioning and change control.

ISV support was outstanding from the large ISVs as Unilever ran into no problems with support for virtualized environments from its big applications vendors — Oracle, SAP, and IBM. Unilever has also been able to virtualize nearly every type of application, including its massive ERP systems and tier 1 applications. However, it faced resistance from smaller ISVs, which generally have lagged in supporting virtual environments. Though no major technical hurdles prevent the virtualization of these applications, support and certification from these smaller ISVs are often lacking.

Overall management is accomplished with several layers. Platform-specific tools from VMware and storage vendors are utilized to manage specific products. They also use a variety of software tools to optimize the SAN. The primary management framework

for servers and storage on the Unix and VMware side is Tivoli from IBM, of which Unilever has a very comprehensive installation. The virtualization management begins with the hypervisor platform tools and feeds into the higher-level Tivoli tools for overall service management and for the attached storage and networking. This gives Unilever the holistic, end-to-end view of the datacenter that it needs to manage business services at the cloud level. Microsoft System Center is used to manage the x86 Hyper-V infrastructure.

Benefits Realized

Today, about 40% of all of Unilever's workloads are virtualized. The company has more Windows servers than Unix servers, but a higher percentage of Unix servers are virtualized, though the company has been pursuing virtualization of both architectures quite aggressively.

Virtualization was a key tool during consolidation, but it also had other effects on operational efficiencies, allowing the company to balance its workloads to get the most out of the underlying physical hardware. De Sa said, "Our run costs were several hundred million less than benchmark because of the benefits of virtualization and consolidation. The price points that we've been able to run at because of virtualization have been very significant."

Virtualization also allowed Unilever to be more agile through nondisruptive change. With Unilever's previous platforms, every time it needed to do upgrades to facilitate releases, perform company onboarding, or take on new business, it had to bring big systems down for several hours to do the upgrade or to allocate CPU, memory, and storage to allow for the business change programs to go forward. That model was no longer viable, and virtualization would give Unilever the flexibility to make changes in a nondisruptive way to allow it to handle the fast changes being thrown at it.

Future Outlook

Looking toward the future, Unilever has several items on its agenda:

- **Network virtualization.** As it has done with servers and storage, Unilever has begun the early stages of network virtualization to support a more dynamic and mobile environment.
- **Workload mobility.** "We're trying to take it to the next level to make our workloads even more mobile and even more portable, and at some point, we want to be able to move workloads between our datacenters and even someone else's datacenter if need be," said De Sa. Increasing use of automation will be a key factor in attaining more mobility for Unilever.

Overall, Unilever's goal is to move to a hybrid cloud model, integrating its private cloud with external cloud resources. Unilever sees cloud as a flexible datacenter resource that can be moved around and scaled up or down, including third-party datacenters that can be tapped into through a self-service console and pay-as-you-go model.

As for whom Unilever will partner with in this cloud journey, De Sa said, "Cloud is an all-encompassing term, so obviously we'll have to work with all the many vendors in our environment to make that work. IBM would be one of our key partners in this area as we currently run our intensive ERP-centric workloads on IBM and have built up an operational trust on their platforms. From what I've seen, they have the technology, the management wherewithal, and the process to be able to do it better than anyone else. It's the one organization that has all the layers of the cake needed for such a dynamic journey."

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