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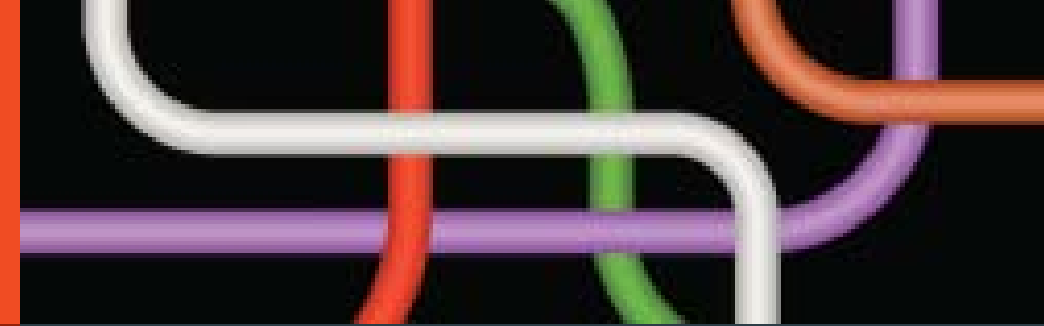
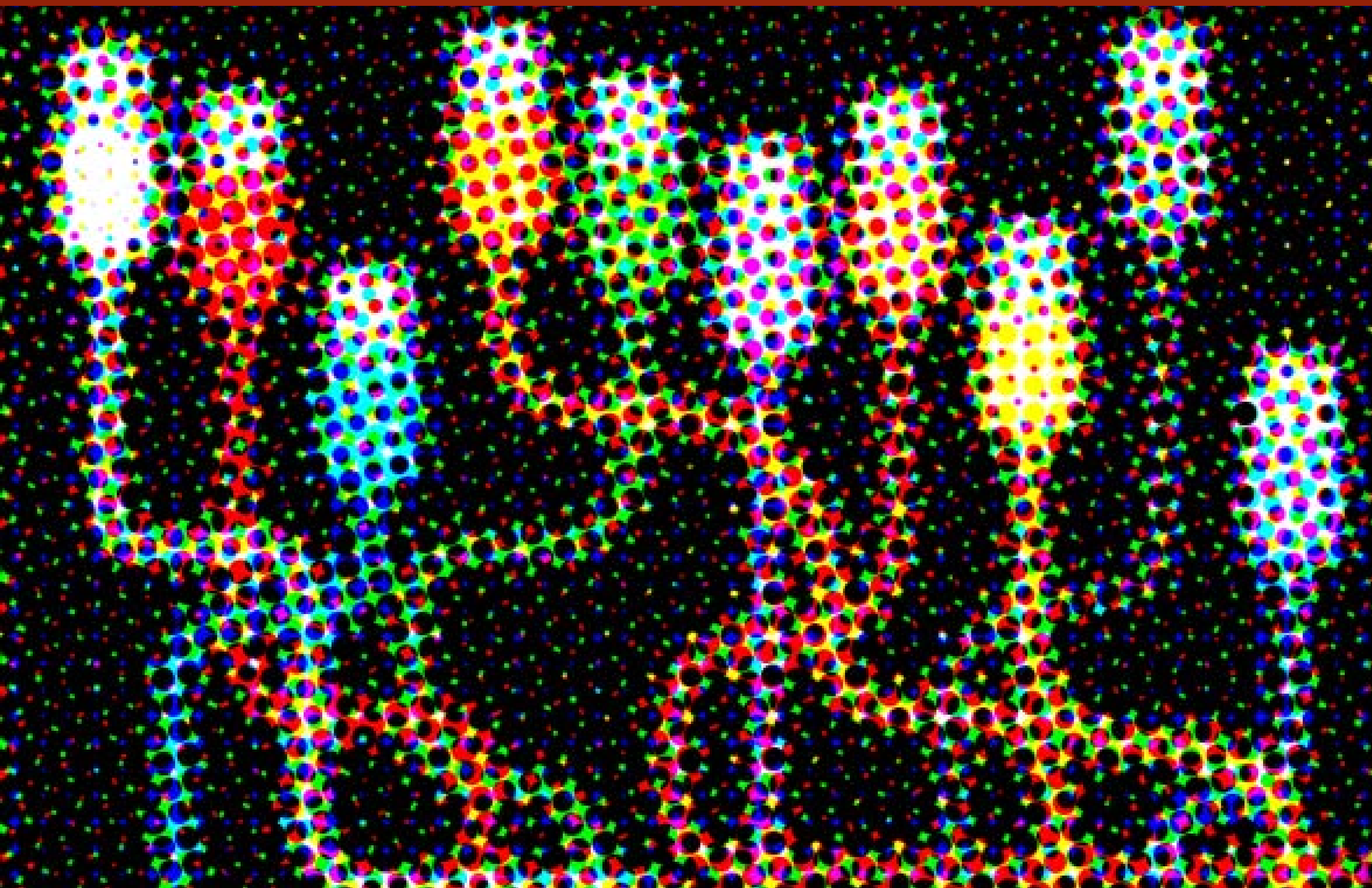
MODERNIZING ENTERPRISE IT



DIGITAL SPOTLIGHT SPRING 2013

Software-Defined Data Center



INSIDE

Abstraction: the new reality

IN THE HISTORY of computing, you can point to a handful of tipping points where a collection of technologies come together to yield dramatic change: Downsized storage and processing begat PCs; LANs laid the groundwork for client/server; a critical mass of widely connected routers enabled the Internet.

But in every case, visionaries needed to invent new software to transform that collection of infrastructure into something qualitatively new. That's what's happening with the software-defined data center today.

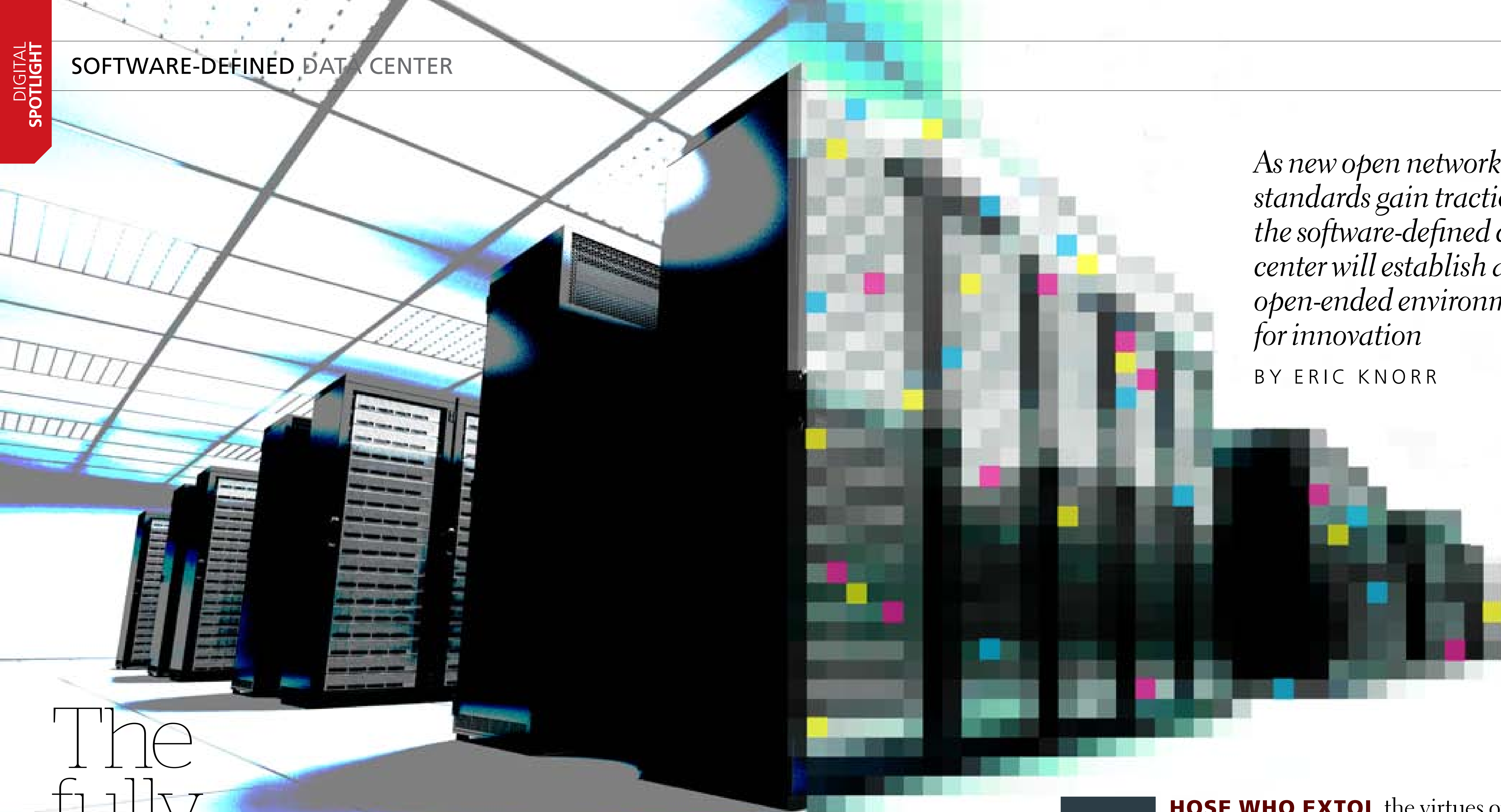
As this Digital Spotlight reveals, we're at the start of a new era in which the data center's physical resources—servers, storage hardware, and networking gear—can be abstracted and applied on demand to workloads without administrators having to worry about manual configuration. This endlessly flexible software-defined infrastructure will open new opportunities impossible to foresee today.

In "Software-defined networking: Bringing virtualization to data center networks," you'll see that the last piece of the puzzle for the new, fully virtualized data center is just now falling into place. Software-defined networking (SDN) supports the creation of multiple virtual networks on top of the same physical network infrastructure, without the hassle and poor scalability of VLANs.

In "Putting the software-defined data center to work," senior InfoWorld contributing editor Dan Tynan details the impressive efforts of eBay—an early, yet advanced adopter of both SDN and private cloud computing. And finally, Paul Venezia, who has written some of InfoWorld's most important stories, dives into the details of orchestration, the heart of the software-defined data center's automation benefits.

It's an earth-shaking time in enterprise technology development and the software-defined data center is at the epicenter. We hope this Digital Spotlight sheds light on one of tech's most exciting trends.

Eric Knorr, *Editor in Chief*



The fully **virtualized** data center

As new open networking standards gain traction, the software-defined data center will establish an open-ended environment for innovation

BY ERIC KNORR

THOSE WHO EXTOL the virtues of cloud computing tend to talk in generalities, using words like “agility” and “scalability” rather than describing exactly how such gains will materialize. But the technology foundation of the cloud boils down to one seminal advance: virtualization.

Virtualization abstracts the resources delivered by hardware infrastructure from the hardware itself. The resources become elastic—"defined" by software rather than by admins crawling around the data center rerouting cables, standing up new boxes, or flipping physical switches. With server virtualization, for example, you simply spin up as many VMs (virtual machines) as you need from a software console—and when demand spikes or when you deploy a new workload, you then spawn many more VMs to carry the bigger burden.

The resources become elastic—"defined" by software rather than by admins crawling around the data center rerouting cables, standing up new boxes, or flipping physical switches.

The software-defined data center takes virtualization to the next level, extending the abstraction to storage and networking. With advanced automation capabilities, administrators can pour on compute, storage, and networking resources as needed.

The software-defined data center already provides the infrastructure for the chunk of the cloud managed by such monster service providers as Amazon, eBay, Facebook, and Google. These innovators have had both the extreme necessity and the technological resources to develop their own, proprietary software-defined data center solutions.

But today, we're at the point where standardized, often open source solutions are being developed for mainstream enterprise consumption. In particular, recent advances in SDN (software-defined networking) promise to put the software-defined data center within reach.

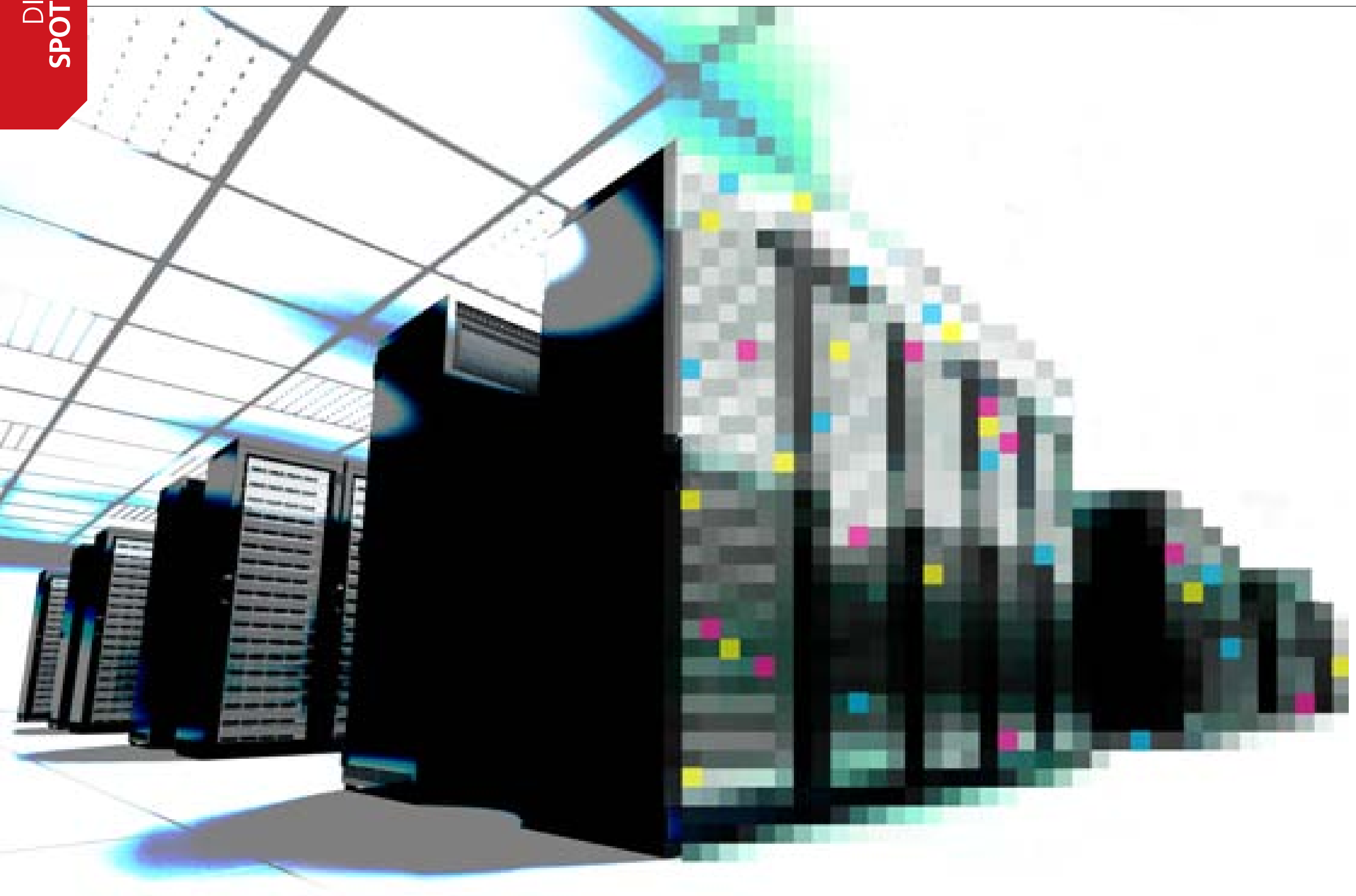
The SDN tipping point

Today, it's relatively easy to manage server virtualization at scale. Through a software console admins can manipulate thousands of VMs, drawing on such advanced features as live migration, automated VM load balancing, and high-availability host clustering.

Such centralized management has not come quite so easily to networking. With conventional equipment, to reconfigure the network, admins must adjust individual devices manually. SDN aims to change all that. To make everything configurable from a central location, SDN separates the control plane from the data plane—creating a central control point for a network full of switches and routers.

For SDN to work, there needs to be a standard way for the control plane and data plane to communicate. The OpenFlow protocol stack, which establishes a standardized interface for controlling network switches, has given birth to a number of networking startups and enjoys the backing of Cisco, HP, and other established vendors. Of course the switches themselves need not be physical; they can be virtual switches that run on the servers themselves. For example, Open vSwitch, a popular open source virtual switch, gives priority to data flows directed by an OpenFlow controller.

The OpenDaylight Project—a new open source project hosted by the Linux Foundation and backed



Perhaps the greatest excitement of all has centered on open source private cloud solutions.

by every major networking player—promises to move the ball forward for SDN. Rather than hammer out new standards, the project aims to produce an extensible, open source, virtual networking platform atop such existing standards as OpenFlow. Most exciting are the "northbound" REST APIs to the controller, atop which developers will be able to build new types of applications that run on the network itself for specialized security, network management, and so on.

The private cloud heats up

The rise in SDN is elevating the viability of private cloud solutions, which provide a management framework for the software-defined data center into which various virtualization solutions plug in and work together. These clouds tend to have many moving parts, including virtualization management, metering and chargeback systems, automated configuration, and self-service provisioning.

Commercial vendors have been developing their own unified private cloud solutions for some time. VMware, for example, covers all the private cloud bases, including performance monitoring, workload-level self-service, resource metering, and with the acquisition of Nicira nine months ago, an advanced SDN solution. In fact, it was former VMware CTO Steve Herrod who, in August 2012, coined the phrase "software-defined data center" in his official blog.

Microsoft has stepped up its game with Windows Server 2012 and System Center 2012, for the first time offering a complete private cloud solution. Through System Center, Microsoft now offers data center orchestration and workflow technologies to let IT pros design services and combinations of services as resource packages. System Center 2012 goes beyond Hyper-V to support multiple hypervisors; it also accepts management data from competing management tools.

Perhaps the greatest excitement of all has centered on open source private cloud solutions. The first of these was Eucalyptus, a private cloud implementation of Amazon Web Services that saw its initial release in 2008.

Another important player is Citrix, which handed its full-featured CloudStack solution to the Apache Software Foundation in April 2012.

In terms of industry momentum, however, OpenStack is the hands-down winner among open source private clouds. A collaborative project launched by Rackspace and NASA in 2009, OpenStack now offers virtual machine management for every popular hypervisor and provides a robust framework for object storage and machine image management. Its most recent releases also include authentication and dashboard monitoring services—as well as Quantum, into which admins can plug various SDN solutions.

The prospects for this open source juggernaut rose sharply in March 2013 when IBM announced that all of its cloud offerings, both public and private, would be built on OpenStack. And at OpenStack's most recent event in April, for the first time, several big enterprise customers were willing to talk about their OpenStack implementations, including Best Buy, Bloomberg, and Comcast.

Soon we'll have the ability to experiment iteratively with all sorts of new data center architectures that cross public clouds and private infrastructure.

With the backing not only of IBM, but also Cisco, Dell, HP, NetApp, Red Hat, and VMware, OpenStack is the odds-on favorite to provide widely accepted open source foundation for the cloud.

Software-defined everything

Is "the software-defined data center" just another way of saying "the cloud"? Not really. "The cloud" is a marketing term for application, platform, or infrastructure services that internal or external customers procure on demand using Web forms. The software-defined data center is the mechanism through which those cloud services can be delivered most efficiently.

As SDN falls into place, the nearest-term benefit to enterprises will be the easing of the network bottleneck in virtualization. Spinning up and moving around virtual machines has become almost too easy, but the network provisioning to accommodate big changes in virtual server loads has been hard manual labor by comparison. That will change over the next few years.

In the long run, who can say where

the software-defined data center will lead? The fact is, the software-defined data center could only begin to happen now because up until the present, we have not had compute, storage, and networking hardware with the capacity to accommodate the overhead of virtualized everything.

Now we do. Soon we'll have the ability to experiment iteratively with all sorts of new data center architectures that cross public clouds and private infrastructure. Just as no one at ARPANET in the 1970s could have anticipated YouTube, no one can predict where the ability to freely provision and configure abundant virtual resources will take us.

Eric Knorr *is editor in chief at InfoWorld.*

Software-defined networking:

Bringing virtualization to data center networks

SDN has the potential to bring the same efficiencies to data center networks as CPU virtualization brings to data center servers

BY ROY CHUA AND MATTHEW PALMER

SOFTWARE-DEFINED NETWORKING (SDN). You've heard about it. You've talked about it in hallways, in meetings, at conferences. Chances are, you want try it in the not-too-distant future. But for all the interest in SDN, many people don't truly understand what it is or what it means for their enterprise.

Social media, mobile devices, and cloud computing have pushed traditional IT approaches to their limits, spurring incredible innovation in virtualization and automation. But although compute and storage have been able to scale by becoming flexible, agile, and virtualized, networks are the one place IT hasn't virtualized.

Enter SDN. In today's cloud environments, administrators can spin up new compute and storage instances in minutes, only to be stymied for weeks by rigid and oftentimes manual data center operations on the network. SDN has the potential to revolutionize legacy data centers by closing the provisioning and management gap between networks and their compute and storage counterparts.

What is SDN?

At its most basic, SDN is an approach to networking that centralizes management of the network by separating the control logic to off-device compute resources. SDN also exposes programmable control APIs to allow applications to orchestrate and automate network services.

SDN increases efficiency by optimizing existing applications, services, and infrastructure. Removing the need for manual configuration of switches and routers reduces errors while allowing applications and services to scale with a speed impossible in legacy data centers. Data center operators are looking to SDN approaches to fulfill one or more of three basic network needs:

- Simplification and efficiency, through consolidation, standardization, and convergence
- Automation and scale, automate people, policy, and processes to help scale
- Assurance and compliance, use programmatic interfaces to reduce human errors and exercise consistent governance control; ensure compliance with policy templates

A brief history of SDN

SDN seems inexorably intertwined with network virtualization and cloud computing, but the initial impetus for its development was innovation, not scalability. Prior to SDN, flexibility and choice in net-

working were an oxymoron. Then, as now, specialized hardware components housed proprietary, vendor-defined software, causing networks to become more fragmented as they grew. Stanford University researchers wanted better ways to conduct networking research and experiment with new networking protocols. Denied access to the proprietary control logic in commercial switches and routers, they created an arrangement that replaced the closed, vendor-specific operating system with one supporting the OpenFlow API, a protocol designed specifically to expose the inner workings of a network switch to external programs.

Researchers used the OpenFlow protocol to separate the control plane from the packet-forwarding plane in network devices, allowing them to modify the control logic to run outside the devices on powerful, inexpensive PCs. A single PC, playing the role of SDN controller, now could provide centralized control over the entire network. Further, the logic that used to run on underpowered CPUs could be retooled to take advantage of multicore CPUs, huge memory spaces, solid-state disks, and global link-state and network flow visibility.

Some purists still view OpenFlow as "true" SDN, but most of the networking world accepts that SDN includes a wide range of approaches and protocols. As innovations in cloud computing make it clear the network can't keep up with more agile, virtualized compute and storage, people begin to see SDN as a practical solution for data center networks and the cloud.

SDN in the data center and beyond

SDN offers incredible potential for flexibility, agility, and scalability in next-generation data centers. Certainly service providers see huge potential for SDN in areas such as service chaining, traffic engineering, bandwidth-on-demand, and dynamic WAN interconnects, but its greatest benefits will be realized through the implementation of network virtualization in the data center. (Incidentally, many service providers view their mobile and WAN networks as early versions of SDNs because they separated the control plane from the forwarding plane years ago.)

Debates abound over the relationship between SDN and network virtualization. Depending on how you define SDN, some people contend it's possible to achieve network virtualization without it. But the fact remains that network virtualization—abstracting logical networks from the underlying physical implementation—is the most prevalent use case for SDN technology today.

When it comes to slicing the network, SDN solutions will be key for establishing multitenancy, or creating multiple, isolated virtual networks on the same physical network. SDN enables you to programmatically create flexible network configurations so you can either connect different servers, firewalls, and load balancers into the existing infrastructure or replicate existing multitier network topologies without having to manually deal with cables or complex command-line operations.

SDN also allows administrators to stretch the network across racks within the data center or even across multiple data centers or clouds. For automation and orchestration, SDN enables coordination and service insertion (firewall, IPS, load balancing, etc.) across all resources, including networks, compute, and storage.

SDN and network virtualization also enable cloud infrastructure providers to essentially run their own Amazon EC2-like services. They can serve multiple departments or customers, providing each with their own isolated compute, storage, and network playground. SDN enables cloud orchestration platforms such as OpenStack and CloudStack to provide on-demand, multitenant networks as part of their private or public cloud spin-ups.

Enterprises will also see business value from SDN solutions in visibility and troubleshooting – namely,

SDN offers incredible potential for flexibility, agility, and scalability in next-generation data centers.

tap aggregation. Instead of having to physically place taps on relevant switch ports, an SDN solution can selectively inspect flows within the network. SDN solutions programmatically record to an analysis device to figure out what's going on, potentially cutting troubleshooting time from weeks down to minutes.

There are certainly other SDN use cases outside the data center, in campus and access networks, including follow-me services, advanced network access control, and even dynamic compartmentalized networks for compliance. But the most immediate gains will be reaped in large data centers, where SDN promises to substantially reduce operational costs. The jury is still out on whether SDN will result in significant reduction on the capital expense side. The commodity data center switch, touted by many as the new reality with SDN's ascent, has yet to hit mainstream.

SDN vendor approaches

The stakes in the swiftly evolving SDN space are high, and vendors are rushing in to establish a footing. Traditional networking providers and upstarts alike are creating their own SDN frameworks and controllers, even as major stakeholders try to define the very underpinnings of the technology.

These days, just about every networking vendor claims to offer some sort of "SDN" product. Layer 2-3 vendors are either embracing OpenFlow or spinning their own form of a flow-control and programmatic API. Layer 4-7 players are moving toward virtualizing their offerings and trying to fit into a software-centric SDN architecture so they can provide on-demand, elastic Layer 4-7 services. A new battleground is brewing around virtual switches, which mirror what their physical counterparts do, only inside virtual machine hosts.

Related to the concept of virtual switches is that of the overlay network. Favored by virtualization platform vendors VMware and Microsoft, overlays "float" virtual network domains on top of a physical networking and virtualization infrastructure. Overlay approaches based on protocols such as VXLAN (Virtual Extensible LAN), NVGRE (Network Virtualization using Generic Routing Encapsulation), and STT (Stateless Transport Tunneling) support the creation of millions of virtual networks that can exist on top of legacy physical infrastructures, moving the network intelligence to the "edge" of the network where virtual switches live.

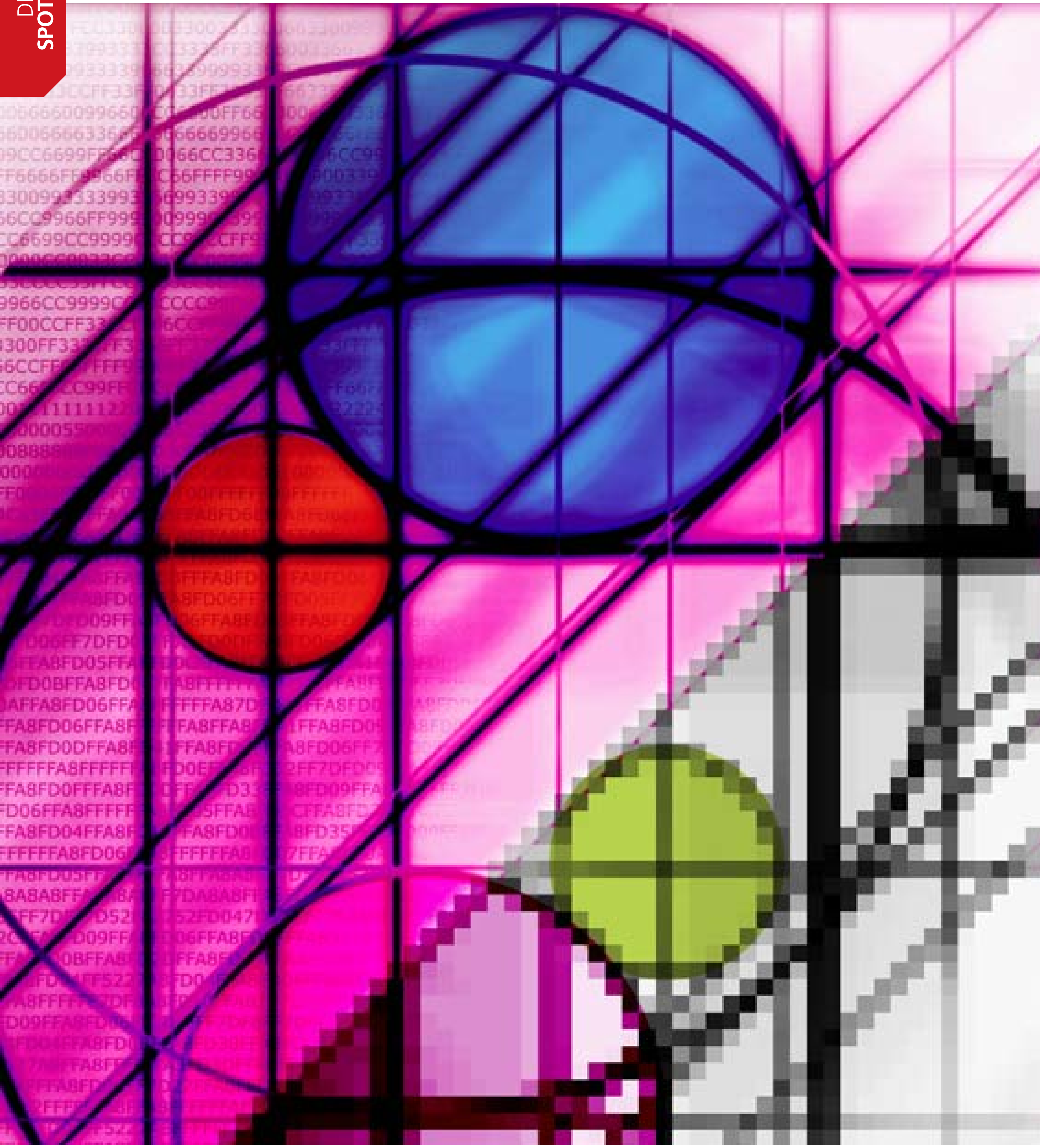
On the control front, established networking vendors such as Cisco, HP, IBM, Juniper, NEC, and startup Big Switch are building their own SDN controllers, which translate application calls into OpenFlow or similar protocols, and in some cases function as a network operating system. Other vendors, including Arista, Brocade, and Extreme Networks, are making current and new switches SDN-compatible by supporting OpenFlow and other programmatic APIs. In fact, most vendors are working to find ways for existing products to work with SDN capabilities, particularly when it comes to orchestration, management and analytics, and automation.

Meanwhile, competing vendor-led consortiums are racing to establish SDN standards for the industry. Industry giants Cisco and IBM came together to define an open source framework for SDN controllers and applications. Supported by other networking heavy hitters, the initiative was folded into the Linux Foundation's OpenDaylight Project to establish an SDN framework and speed SDN adoption. Dell shunned the project in favor of starting an SDN standardization committee within the Object Management Group, a computer industry standards association.

Time will tell whether the consortiums will provide the more transparent approach to SDN standardization they promise, or whether—as cynics fear—the industry-led initiatives will essentially trade one form of vendor lock-in for another.

Few innovations have burst upon the networking and data center scene as dramatically or as rapidly as SDN. But for all the promise it offers, the technology is in the early stages of the typical enterprise software market evolution, and acquisitions continue in the rapidly changing environment. Although it's too soon to tell which SDN approaches will rule the data center or how they will impact traditional networking, it's clear that SDN and programmatic APIs in the network are here to stay. Cloud infrastructures will demand no less going forward.

Roy Chua *and* **Matthew Palmer** *are partners at SDNCentral, an independent online community and resource site focused on software-defined networking and network function virtualization.*

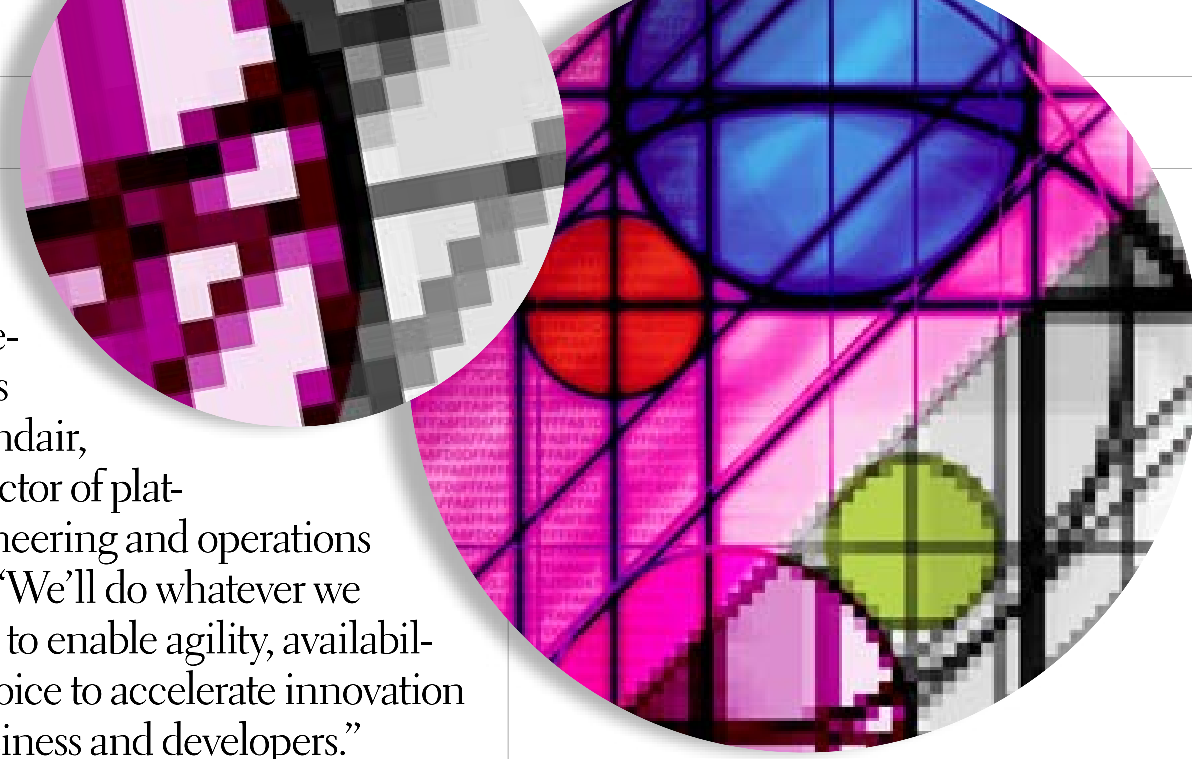


eBay and PayPal put the software-defined data center to work

Two Internet companies with rapid change in their DNA adopt OpenStack and Nicira network virtualization to attain new levels of agility

BY DAN TYNAN

WHEN EBAY WANTED to build a software-defined data center for its internal cloud, it chose OpenStack to help manage it. Just two years after the open source cloud management software was introduced, eBay decided it was ready for deployment, at least on a trial basis. The SDN (software-defined networking) portion of the solution came in the form of the Nicira Network Virtualization Platform, now owned by VMware, which was tightly integrated with



OpenStack's network management component, Quantum.

"We'd been looking to virtualize our network for a while," says JC Martin, cloud architect for eBay Marketplaces. "Nicira NVP supported OpenStack right out of the box. A community-supported solution that can automate end-to-end creation of a private cloud with virtual networks was just what we were looking for."

They started by building a small experimentation environment for eBay Marketplaces, enabling developers to spin up test networks on demand, then deprovision them when they were no longer needed. eBay used NVP and OpenStack to create virtual private clouds for different classes of users—for example, one for developers, another for external experimentation with full access to and from the Internet, says Martin. Each virtual private cloud has different capabilities depending on which virtual network they have access to.

"Based on the class of service, we can filter out traffic and enable or disable features," he says. "We can also allow other organizations within eBay to have their own isolated private cloud environment and define what kind of access or control they want for their users. It's a way for us to implement the equivalent of physical environments on top of a shared infrastructure."

By the end of six months more than 1,500 eBay developers were accessing the internal cloud. By the end of this year, eBay plans to have a large percentage of its internal infrastructure on the new platform, says Martin.

PayPal catches the wave

Martin's colleagues at eBay's sister company PayPal couldn't help but notice the small revolution underway across the virtual halls. OpenStack also fit neatly into many of PayPal's guiding principles: It is open source and thus would not lock the online payments company to a particular vendor. It had a strong development community following industry best practices, and deploying it would allow PayPal to leverage eBay's investment and growing expertise.

"We saw OpenStack as a way to help us get products to market faster than our competition," says Saran Mandair, senior director of platform engineering and operations at PayPal. "We'll do whatever we need to do to enable agility, availability, and choice to accelerate innovation for our business and developers."

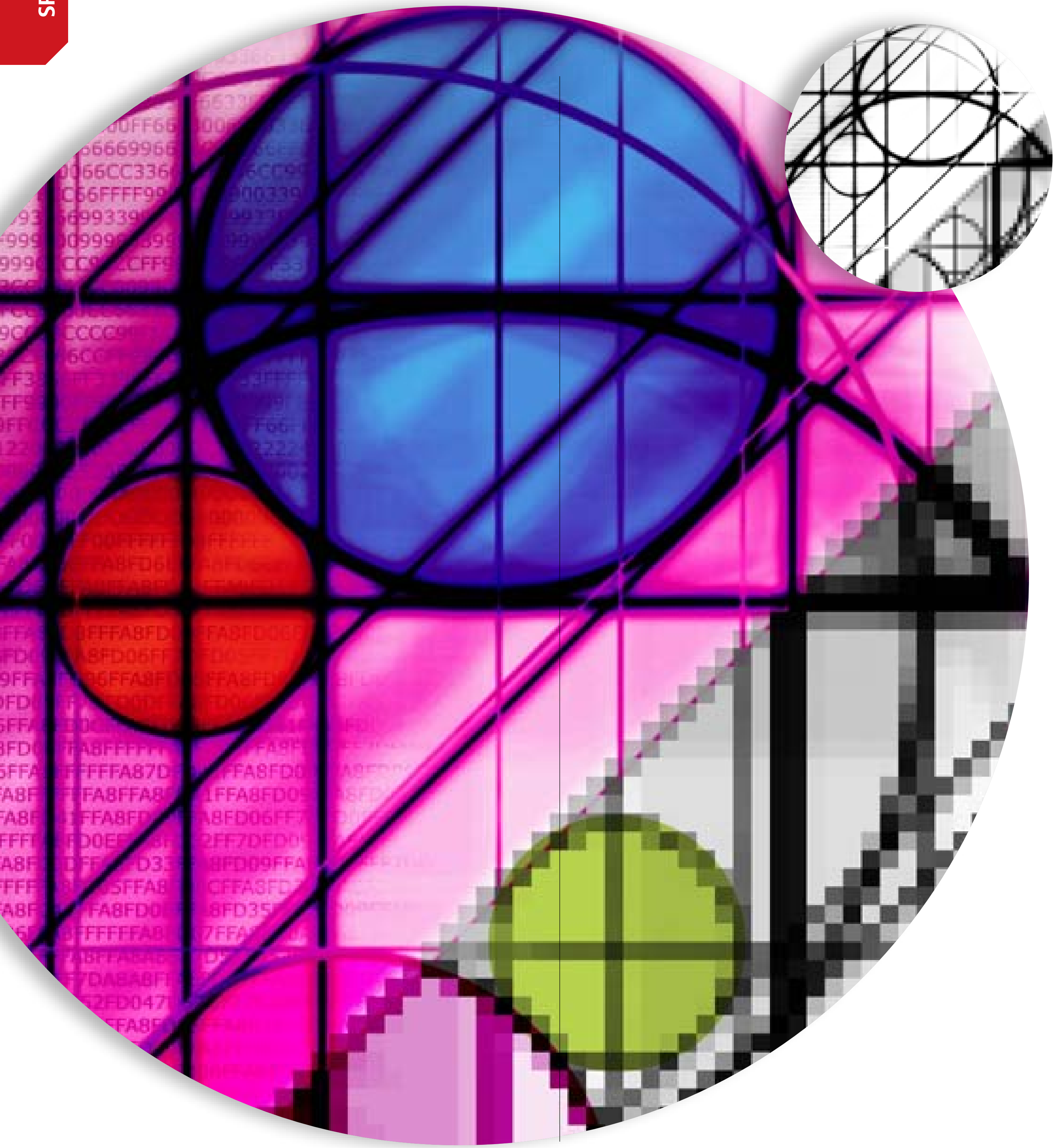
PayPal is still piloting its first software-defined networks, but it has already put OpenStack to work, running its digital wallet and other customer-facing apps on an OpenStack-managed cloud since January of this year.

"At PayPal we handle $5,277 in total payment volume (TPV) every second in Q1 2013," says Mandair. "The front-end Java application stack is currently powered by OpenStack. There are ongoing execution plans to extend this to the rest of the infrastructure in PayPal this year."

But it was on its internal development network where PayPal saw the most profound changes. Last year it took the company an average of 49 days to provision infrastructure for new applications in production, says Mandair. Now, running on the OpenStack cloud, the average onboarding time, including infrastructure provisioning, is seven days. And while using software to automate provisioning played a big part, it wasn't the only factor. The team also simplified and eliminated process handoffs between multiple teams, with the goal of offering a self-service option to developers enabling them to execute in minutes.

Completing the virtualization puzzle

eBay's and PayPal's move to SDN is part of an enormous paradigm shift that began with the rise of virtual machines, says Kelly Herrell, vice president and general manager of



the software networking business unit for Brocade. Virtualization has already revolutionized the compute and storage pieces of the IT puzzle, he says. Now it's networking's turn.

"Before virtualization, you had guys pushing wheelbarrows full of black boxes down the aisles in the data center, trying to figure out where to plug them in," he says. "It was like rubbing two sticks together to build a fire, when what you really need is a microwave. Much of the IT infrastructure has traversed to a software model, but we're still waiting for the network to catch up and become as agile as the compute side."

Open source cloud management platforms have typically been used by telcos, cloud service providers, and labs and universities; now they're starting to gain traction in the enterprise, says Aneel Lakhani, a research director at Gartner.

"We're beginning to see enterprises do pilots and small-scale deployment of open source cloud platforms, with a few leading-edge orgs already at large scale," he says. "The main driver is economics. It can be cheaper over the long haul in certain use cases to do it yourself than rely on public cloud providers or pay license fees for proprietary commercial software."

The integration of software-defined networking is a significant maturing point for any open source platform, he adds. "The ability to cheaply replicate a Web-scale cloud environment, as well as recent support for multiple networking and storage options, makes it much more interesting to customers."

It wasn't until Nicira was acquired by VMware last July that most people made the connection between SDNs and OpenStack, says Kyle MacDonald, VP of cloud at Canonical Software, distributors of the OpenStack-based Ubuntu Cloud.

"The ability to redesign the network in real time—and support all the virtual machines no matter where they needed to go—was the magic part," he says. "Suddenly that made building a cloud very easy. And as it got easier, we began to see rapid market adoption of OpenStack."

Still, eBay isn't married to any single-vendor solution, says Martin.

By using an open source solution, it doesn't have to be.

"The main reason we are using OpenStack Quantum is to provide an abstraction on top of the capabilities of SDN," he says. "We have a multivendor policy at eBay, so today we are using Nicira, but we regularly evaluate our technology providers and want to keep our options open."

Cloud formation

At this point only a handful of large enterprises have deployed SDN and OpenStack on as large a scale as eBay and PayPal. That means the pair had to blaze a path through some unknown territory. For PayPal, the biggest technical hurdles it encountered were availability and performance at scale, says Mandair.

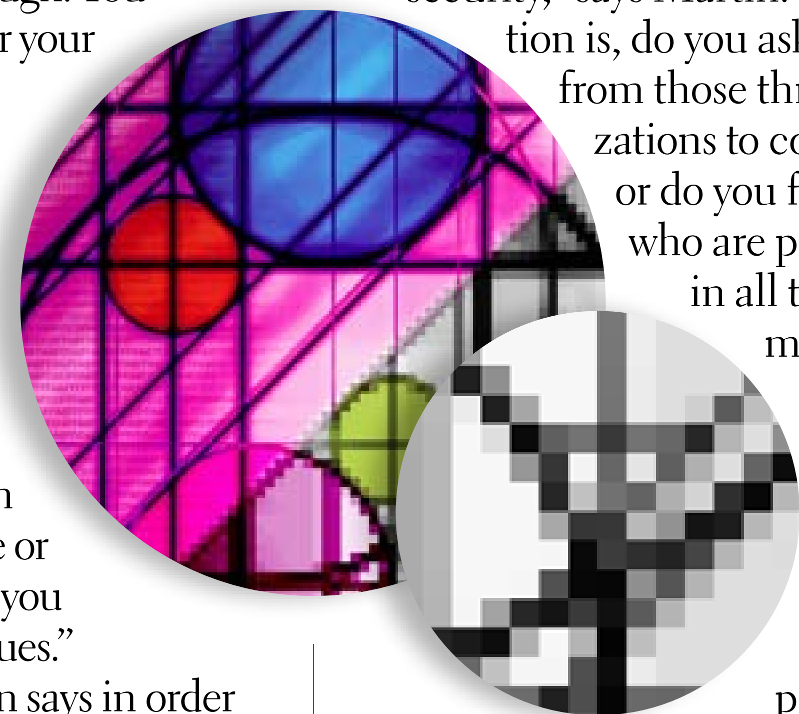
"We had to build some custom solutions to meet our high-availability needs," he says. "And some performance tuning issues that aren't visible when running OpenStack on a small environment become more evident as it scales. There was not a lot of help available from the community on that, so we had to chug through most of that ourselves."

Still, technical barriers were outweighed by business, process, and cultural issues. Adopting automation software is a nice way to automate your network and infrastructure, says Martin, but it isn't enough. You also need to reengineer your business and software processes.

"The main hurdle is to solve your process issues first," says Martin. "I like to say, simplify first, automate next. If you try to take an as-is situation and make it self service or otherwise automate it, you can run into a lot of issues."

For example, Martin says in order to automate its processes eBay had to revise how it performed change management. Originally, every change request was required to go under review; now instead, the software making the change has to be approved.

"That's the type of reengineering we had to do to enable automation and agility," he adds. It also meant reengineering eBay's IT workforce and thinking outside traditional organizational boundaries.



"When you need to debug a problem on virtual network, you need expertise in servers, networking, and security," says Martin. "The question is, do you ask people from those three organizations to collaborate, or do you find people who are proficient in all three domains? We've found it's more efficient to have well-rounded people who have a good understanding of all three layers."

Agility is key

Mandair says the key to a successful deployment is to think big, but execute small.

"From a technology perspective, I think you should have huge aspirations, but when it comes to execution you want to narrowly define your focus," he says. "Our initial plan was to take one specific app from our site and automate it end to end. We didn't try to do it for ten apps at once. Once you exercise that muscle, you can expand it to other applications. But if you start out with too broad a focus, your execution won't be as smooth."

The ultimate goal is to enable businesses to stay competitive by moving at the speed of innovation. For most enterprises, the bottleneck isn't computing power or creativity, it's inflexible infrastructure.

"We are trying to make a data center operating system agnostic of compute, storage, network, and hypervisor," says Mandair. "Our goal is to make a platform that enables agility, agility, agility."

Dan Tynan *is a contributing editor for InfoWorld, author of the* ***Tynan on Technology*** *blog, and co-founder of* ***eSarcasm****, an award-winning geek humor site. Dan has been writing and editing stories about technology and its discontents for more than 20 years.*

Orchestrating the data center

Data center orchestration breaks down conventional silos and enables a whole new level of automation

BY PAUL VENEZIA

DATA CENTERS HAVE been always been built on four pillars: servers, networking, storage, and security. Each pillar must be designed, built, and managed with an entire cohesive data center in mind, one that will deliver a functional, scalable, and stable computing environment.

In today's conventional data center, each pillar is managed separately. Servers, networking, storage, and security all come with their own hardware, software, personnel, and specialized knowledge base. Each one is its own silo. The goal of an orchestrated, software-driven data center is to combine those pillars into a single platform that is tightly integrated and managed, enabling a more fluid and reactive solution.

Virtualizing the data center network

As we look at the conventional data center, we see a collection of network switches and routers connected to servers, storage, and security devices. The network is designed with VLANs, access lists, trunks, and subnets, all managed within the switches and routers themselves.

Network admins configure and manage switches and individual switchports to provide connectivity to servers, storage, and security devices based on the needs communicated by the server, storage, and security teams, bridging a gap of knowledge that exists between all of these groups. Once data leaves a server, it is handled wholly within the network purview until it arrives at its destination.

Enter SDN (software-defined networking), which enables a virtualized networking environment. With SDN, the switches themselves are left largely untouched, requiring only a relatively basic configuration. Rather than configuring a large number of VLANs, the switches are left as pure Layer-2 devices, connecting clusters together on the same logical network. This moves the onus of traffic acceptance, direction, and segmentation away from the network layer and onto the hypervisor layer running on the virtualization host servers.

This achieves several goals. First and foremost, admins no longer need to interact with multiple, disparate network devices from multiple vendors to properly configure network paths. Rather than configuring a switch to support a specific network topology, that configuration is handled by the hypervisor using traffic encapsulation.

For example, if we needed to create a separate logical network to support a new application stack running on virtual servers, we could define that network within the same management framework we use to manage the VMs themselves. We can permit only certain virtual servers to connect to the new logical network and define QoS and policy rules for the network as a whole or for certain virtual servers independently -- all from a single workspace.

Traditionally, this would require configuration of a new VLAN and QoS rules on network switches, followed by additional configuration within the hypervisor to connect to those new VLANs. SDN removes a considerable amount of manual labor from the process.

Grand unification

The efficiencies gained through SDN also benefit the security pillar. Because we are now controlling network communication at the hypervisor level, we can create security policies and rules to govern that traffic. We can build virtual firewalls that limit traffic to or from networks and specific virtual servers. We can also build virtual load balancers that can distribute loads across many servers, all from the same central management framework.

We can also work with storage within this framework. With APIs that allow centralized management of storage resources, we can dynamically create LUNs (logical unit numbers) to support new virtual server builds or manage existing LUNs based on manual configuration or automated workflows. If the virtualization framework can inspect and control storage, it has visibility into storage constraints and availability, and can thus make decisions based on those variables to alleviate congestion or streamline new deployments.

Of course at the center of it all is the management of the hypervisors and virtual servers that comprise the virtualized data center. By integrating these pillars, we allow for much smoother interaction among various

[We can build virtual firewalls that limit traffic to or from networks and specific virtual servers.

aspects of the data center and greater automation. In addition, we also allow for data center extensions that were simply not possible with traditional networking, such as the ability for an entire data center to fail over to another physical location without intervention. We can even move running virtual servers between physical locations without any loss of service.

Provisioning on demand

We can now provide a robust, automated, self-service approach to resource requests. If a department or workgroup needs new computing resources, it's possible to allow them to access a Web application that permits them to choose their desired resources, including CPU, RAM, network, and storage requirements, with each resource attached to a chargeback cost. Once those choices have been made, the orchestrated data center can provide those resources with little to no manual intervention required, and provide auditing for chargeback to the department that requested the resources.

As an example, we might have a new project that will require a development and production application stack. This will require several front-end servers, application servers, and database servers. It will also require restricted access to the development environment and access to the Internet for the production environment. In a traditional data center, this would require the efforts of those responsible for every pillar, from servers to storage, networking, and security. Switches would be configured, appropriate storage would be defined and made available to those virtual servers, and internal and external firewalls would be reconfigured to allow the appropriate access. All of this would require formidable time and administrative effort.

This self-provisioning goes beyond simply spinning up clones of template-based virtual servers

With an orchestrated, software-defined data center, all the pillars can be managed from a central point and automated through policy and workflow creation.

In such an environment, a department could peruse a list of available resources and select the ones that meet its needs -- everything from the number of CPUs per server type, to the storage each will need, and even the network access between them. Once given the requirements, orchestration processes will determine the most appropriate hypervisors to place the virtual servers, the most appropriate storage to be used, and will then configure the network to accommodate the request.

This self-provisioning goes beyond simply spinning up clones of template-based virtual servers -- it can also take into account service tiers within the data center to best match the needs of the request. The production environment would be better suited to have access to faster CPUs and RAM, as well as SAS (serial attached SCSI) or SSD-based storage arrays. The development environment, however, will not need CPUs quite as fast and can live with slower disk. Thus, the cost to deploy the solution is less for the requesting department, and resources across all tiers of the data center can be put to suitable use. Moreover, with chargeback or showback capability, the requesting department can actually see for itself how much resources cost.

Once the request has been made and approved by an administrator, new virtual servers are defined, storage is requested from the appropriate storage arrays and connected to those virtual servers, networks are defined and configured, and firewall rules are created to accommodate the new topology—all without manual intervention.

Not only does this streamline the build process and lower overall cost, but it also reduces the potential for er-

We can now provide a robust, automated, self-service approach to resource requests.

ror or miscommunication throughout the build process. It also can streamline the chargeback process, because every resource has been self-selected with predetermined costs attached.

Disaster recovery

Looking further out, we can see how orchestrated data centers can assist with disaster recovery and data center fluidity goals. By reducing the reliance on fixed networking, we can create shared subnets between physical data centers. This means that an IP subnet can technically exist in two different physical data centers at the same time. If the lower-level network is not responsible for IP traffic direction, hypervisors at one data center can maintain knowledge of the actual location of virtual servers at another data center, and transmit data to them across high-speed links as if they were within the same building. This is also true for storage and security elements.

Thus, it becomes possible to migrate virtual servers from hypervisors in one physical data center to hypervisors in another, without interruption. This opens the door to many new possibilities, such as the ability to transition the running services of an entire data center to another physical location if a major storm or geologic event is imminent. Rather than respond to an outage due to atmospheric elements, we can eliminate that possibility altogether before the outage occurs.

Additionally, we can use this type of operation to manage unexpected surges in requests or other overcapacity situations by utilizing resources at another physical data center if the load requires. Naturally, this requires high-speed data connections between data centers, as the volume of traffic is high, and the latency must be kept low.

The benefits afforded by orchestrating one or more data centers in this way are many – and were not possible until very recently. The concept of cold and hot-site data centers and skillset silos will fade when one or several data centers can function as a single logical unit, orchestrated by software that has visibility into each of those pillars.

Paul Venezia *is an independent IT consultant and a senior contributing editor for the InfoWorld Test Center. His InfoWorld blog, The Deep End, posts weekly.*

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InfoWorld
501 Second St.
San Francisco, CA 94107
415.978.3200

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IDG Enterprise
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IDG Enterprise
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Framingham, MA 01701-9208
508.879.0700 (Fax) 508.875.4394

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