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How Server And Network Virtualization Make Data Centers More Dynamic

A commissioned study conducted by Forrester Consulting
on behalf of Cisco Systems

FORRESTER®



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Executive Summary

Server virtualization has become commonplace, and the question of whether to virtualize has been replaced with “are we moving fast enough?” But what are the barriers that keep firms from virtualizing more of their production environments? In October 2008, Cisco Systems commissioned Forrester Consulting to research the answer to this and other questions. Forrester surveyed 240 firms with experience in running medium and large virtualized server environments to investigate these questions.

Forrester found that as server virtualization usage in production environments has increased, so has its criticality. Correspondingly, as the use of live migration and blade server technologies has become commonplace, firms are increasingly focused upon guaranteeing performance and availability of their virtual environments from an end-to-end perspective. Looking beyond the boundaries of the VM itself, there are operational challenges today in ensuring that network and storage configuration policies are followed uniformly. Fortunately, these and other maturity issues will be addressed by better management and virtualization technology over time. Forrester believes that server and network virtualization technologies will become increasingly integrated to produce more dynamic data centers where administrators have greater visibility and control over the quality of service provided by their virtual infrastructure.

You can take a number of technical and organizational measures today that will allow you to get more out of your existing infrastructure and progressively capitalize on virtual infrastructure as it matures.

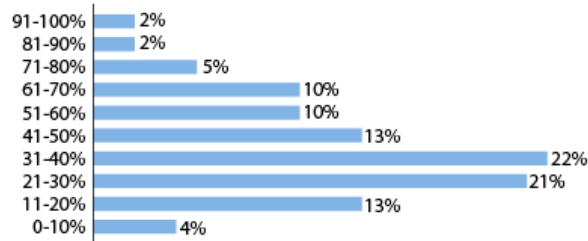
Virtualization Is Everywhere

IT executives are asking how far they can drive virtualization and have begun to set aggressive targets for widespread use of server virtualization in production server environments — 61% of survey respondents plan to virtualize more than half of their enterprise production x86 servers in the next two years (see Figure 1-1).

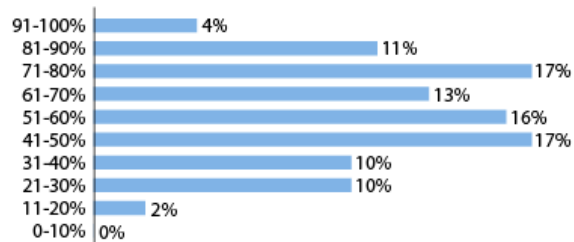
Already, the use of x86 server virtualization is widespread in production server environments. Seventy-three percent of our survey respondents are running production environments with more than 50 virtualization hosts. Furthermore, almost 84% have virtualized more than 21% of their production server environments (see Figure 1-2).

Figure 1: Virtualization Is Being Used Extensively In Production Environments

1-1 "What percentage of your production x86 server systems are virtualized?"



1-2 "What percentage of your production x86 servers do you believe will be virtualized in the next two years?"

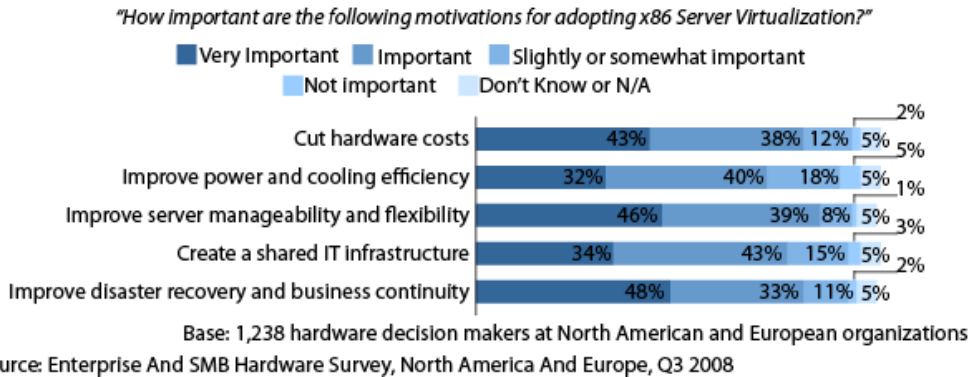


Base: 204 IT and network decision-makers and influencers.

Source: A commissioned study conducted by Forrester Consulting on behalf of Cisco

Firms initially deployed virtual servers to improve overall hardware utilization, which allowed them to greatly reduce their server purchasing. But today, the reasons for using virtual servers are much more strategic in nature. Consolidation is still a strong motivation, but equally important are improving disaster recovery and improving server flexibility (see Figure 2).

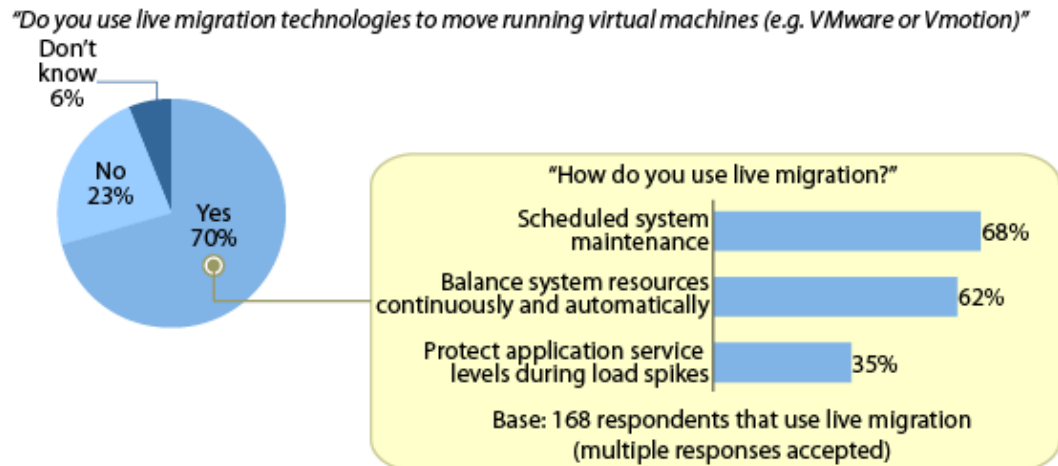
Figure 2: Cutting Hardware Costs Is No Longer The Sole Reason For Virtualization



As Experience Increases, Firms Have Come To Rely On Advanced Capabilities

Server virtualization technologies have been available on x86 systems for roughly ten years, and 55% of respondents now tell us that their firms have two or more years of experience in running the technology in both production and non-production environments (see Figure 3). As your organization becomes more experienced with server virtualization and uses it for more production systems, advanced features like live migration become important to scheduling system maintenance and balancing resource consumption. In fact, 70% of the organizations we surveyed use live migration features. As our respondents are experienced with server virtualization, 62% of these firms use live migration for automatically balancing system resources — an advanced use of the technology compared with scheduled maintenance (see Figure 4).

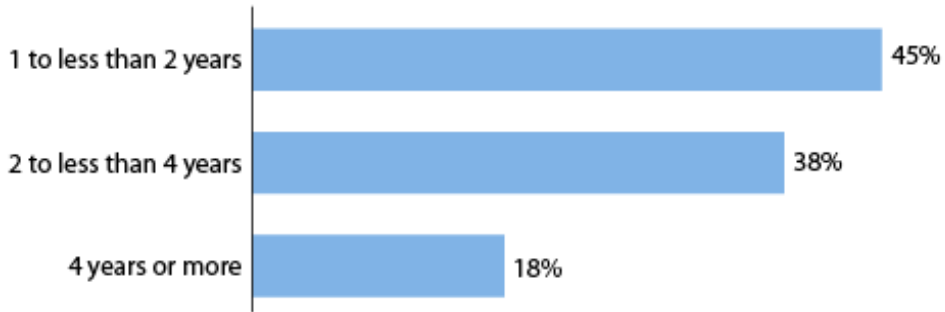
Figure 3: More Than Half Of Respondents Have Two Or More Years Of Experience With Virtualization



Base: 240 IT and network decision makers
Source: A commissioned study conducted by Forrester Consulting on behalf of Cisco

Figure 4: Most Respondents Use Live Migration Technologies

"How long has your firm been using server virtualization in production or non-production environments?"



Base: 204 IT and network decision-makers and influencers.

Source: A commissioned study conducted by Forrester Consulting on behalf of Cisco

Virtualization Maturity Still Has A Long Way To Go

Despite their experience, most firms (69%) still use traditional server administrators to run their virtualized environment. Twenty-nine percent, however, have created a relatively new job description — the virtual infrastructure administrator — to run their virtual server hardware (see Figure 5). We believe that the creation of dedicated virtual infrastructure administrators is vital to running a large number of virtual servers. From a logistical standpoint alone, it isn't practical to train all of your existing server administrators to take on this new responsibility if you have a large environment. Specialization is more efficient because a relatively small number of virtual infrastructure administrators can oversee the entire virtual environment, preventing the majority of your server, network, or storage administrators from having to worry about the underlying infrastructure. At first, your virtual infrastructure management group may be just a handful of administrators that share responsibility for virtual server, network, and storage tasks. At scale, however, IT organizations have begun to form multidisciplinary virtual infrastructure teams that are comprised of server administrators as well as previously walled-off network and storage administrators.

Figure 5: Enterprises Are Starting To Create Dedicated Virtual Infrastructure Administrators

	Virtual Infrastructure Administrator	Server Administrator	Network Administrator	Storage Administrator
The physical server hardware running VMware, Citrix, or Microsoft virtualization	29%	69%	19%	7%
The hypervisor itself	45%	49%	15%	2%
Operating systems within virtual guests	25%	65%	20%	2%
Networks within the virtual environment	17%	20%	79%	2%
Storage within the virtual environment	17%	29%	14%	62%

Base: 204 IT and network decision-makers and influencers.

Source: A commissioned study conducted by Forrester Consulting on behalf of Cisco

Forrester believes that there are four steps to greater virtualization maturity that your firm should pass through as you expand your production virtual server environment:

- Step 1: Standardize.** At the outset of your virtualization implementation, your focus should be on building out a solid foundation for a production VM environment. This includes basic monitoring and provisioning tools, as well as a standardized VM platform. Once beyond the pilot phase, many firms institute standards that prescribe virtual machines for most new server purchases. In addition, you should lay the organizational foundation of your administrative team, which ought to include a core team of virtual infrastructure administrators with skills in server, network, and storage management.
- Step 2: Consolidate.** After building a solid production environment, many companies ramp up their usage of virtual servers by consolidating existing systems. These systems are often selected for their low utilization, vendor support of virtual machines, and lower application complexity. This allows most companies, such as the respondents to our survey, to virtualize at least 21% — and often more — of their physical servers.
- Step 3: Advance workload management.** After consolidation efforts virtualize most of the easy targets in your environment, you can push hardware utilization by using live migration and workload management technologies within app silos. Today, most virtualization hosts still run at low utilization — with perhaps half as many VMs as they could support. While many firms use workload management today, it is still considered a safety feature that kicks in when utilization spikes — but not something that you regularly plan to use.
- Step 4: Share resources between application domains with service level guarantees.** Through advanced use of workload management and performance monitoring tools, you will eventually be able to virtualize the majority of your application portfolio and expand use of workload management tools across app silos. But there's more work to be done by the industry too — server, storage, and network infrastructure are becoming more virtualization-aware, and their management tools are just beginning to integrate with your

virtual server management. These improvements will allow VMs to run at bare metal speeds with guaranteed performance and availability.

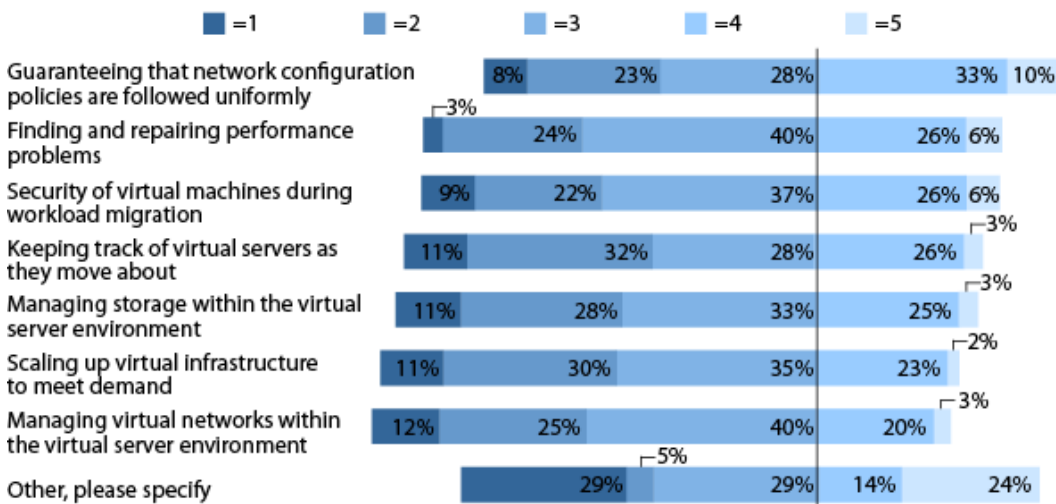
Management Challenges Remain

Virtual servers have unique management challenges that you must overcome in order to reach higher levels of scale and efficiency. According to our research, firms are more concerned with managing network configuration policies and finding and repairing performance problems than other administrative challenges. And their concerns are warranted, for there is no silver bullet that guarantees the uniform configuration of networks across virtual servers or can track down the cause of every phantom performance problem (see Figure 6).

When VMs move between physical hosts, the configuration of the network outside the virtualization host machine doesn't move with them. That means that the network configuration must be the same for any host where a VM might be executed. If there is a configuration error, certain resources may become inaccessible after a VM moves. Furthermore, VM performance is affected by configurations and resource constraints at multiple levels, both within the virtual environment and within your existing network and storage environments — with few means of getting end-to-end visibility or control. The abstraction layer created by virtualization platforms is partly responsible for this lack of visibility and control, but management tools themselves also bear some of the blame. Tools are still maturing, and many of today's virtualization management tools are either exclusively focused on the virtual environment (ignoring its physical dependencies) or so specialized that they only give administrators a tiny part of the big picture.

Figure 6: Applying Network Configuration Policies Continues To Prove Difficult

Please rate the level of difficulty managing the following aspects of your virtual server environment, where 1 = not difficult at all, and 5 = very difficult.



Base: 204 IT and network decision-makers and influencers.

Source: A commissioned study conducted by Forrester Consulting on behalf of Cisco

Unfortunately, these administrative issues are directly related to the attributes that make virtual servers so attractive. We *could* lock down our virtual machines and bind them to physical server or network resources — and some security-obsessed IT shops do — but that's sacrificing too much. As most firms want to use virtual servers to improve server flexibility and disaster recovery, we need better management and smarter infrastructure so that we can retain:

- **Portability of virtual machines.** The files that define our virtual machines are completely portable between physical server types (and often hypervisors from different vendors), which makes them extremely well-suited to disaster recovery.
- **Abstraction from physical resources.** Today's virtual machines have a minimum level of awareness about underlying infrastructure. We could solve a lot of headaches by letting VMs see more of the hardware and its proprietary capabilities — but we'd be headed back to a much more siloed data center.
- **Live migration capabilities.** One of the most useful features of virtual server platforms is also one of the most perplexing to legacy management tools and infrastructure. Live migration is easier and cheaper to use than clustering. As the majority of our survey respondents have found, live migration makes routine maintenance and workload management much easier.

Blade Servers Have Just Begun To Address The Needs Of Virtual Servers

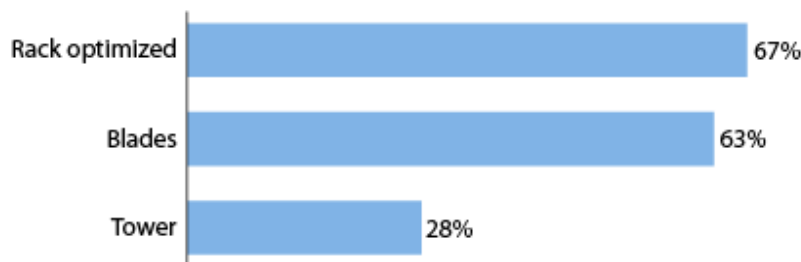
Blade servers have been around for years, but their true capabilities are just starting to come into play now. Blades have been typecast as high-density servers as a result of early systems that were built to run scale-out workloads like Web servers. More powerful systems have allowed blade servers to run all types of enterprise workloads, but some misconceptions still persist. For example, 67% of respondents use rack-optimized servers for running their virtual environments, and close to the same number — 63% — said they used blade servers.

Although blade systems offer consolidated management and shared I/O, most virtual infrastructure administrators see them as little more than a high-density computing environment. As a result, companies that are not space-constrained in their data centers overlook blade systems because they see no real benefit in using them (see Figure 7).

In addition to their higher density, some firms have begun to recognize that blades are a smarter choice because they use substantially less power than older server designs. Furthermore, Forrester believes that the shared I/O available in many blade systems offers lower costs through savings on expensive network ports, as well as greater flexibility for virtualized systems.

Figure 7: A Surprising Number Of Enterprises Claim To Use Blades For Virtual Machines

*"What type of servers do you use to run your production virtual environment?"
Multiple responses accepted*



Base: 204 IT and network decision-makers and influencers.

Source: A commissioned study conducted by Forrester Consulting on behalf of Cisco

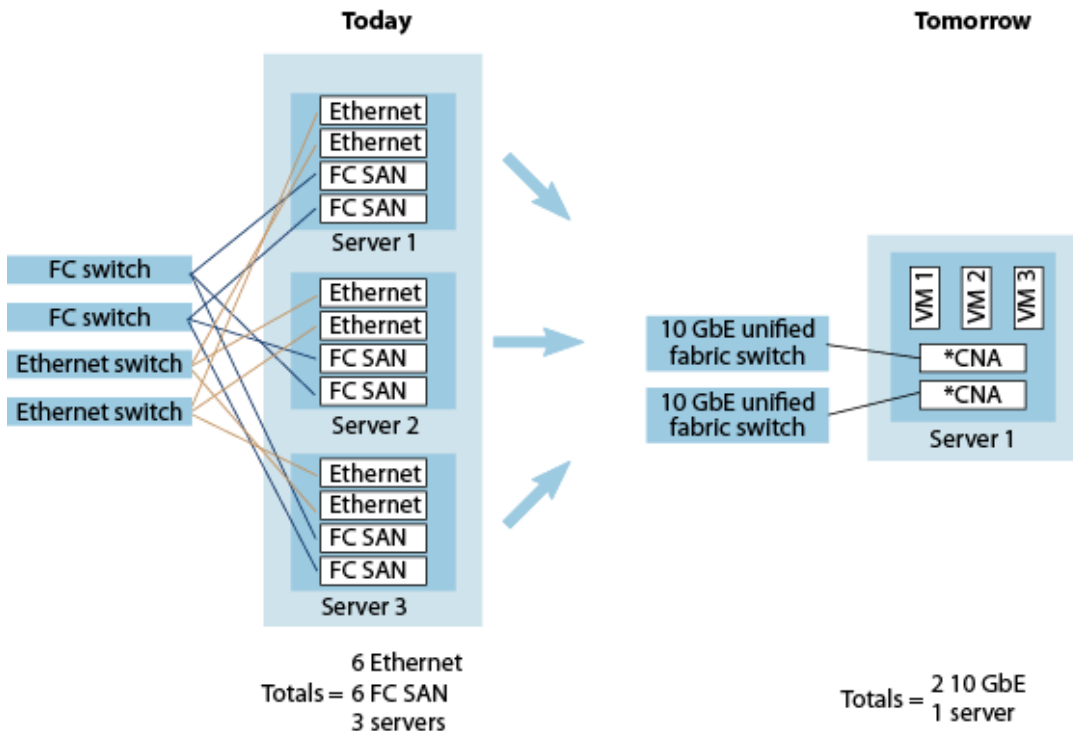
Begin Building A Dynamic Data Center Network

To enable virtualization of any application and lower the cost per VM, we need to overcome the performance and manageability barriers that keep us at around 20% virtualized today. What can the network do to overcome this?

The network can make connectivity and policies more fluid to complement virtual servers. With the creation of InfiniBand in the late 1990s, the industry has been moving more quickly toward shared I/O for commodity x86 servers. Like virtualization, shared I/O was first developed for high-end servers that needed extremely fast intersystem communications for clustering. Although InfiniBand didn't take off, other high-speed network technologies like 10 GbE are poised to simplify data center networking. Today, you can begin building your network infrastructure to support more advanced virtualization efforts. Your network should deliver two main virtualized network services:

- **A very fast, low-latency network pipe over which all I/O can be consolidated.** That one pipe would encapsulate multiple Ethernet and Fibre Channel ports over a single high-speed fabric.
- **The virtualization of multiple I/O adapters.** Servers using a form of shared I/O would not need to be configured with lots of various redundant Ethernet or Fibre Channel adapters for different kinds of physical networks. A major advantage would be a drastic reduction in the number of adapters and ports — a 4 GB Fibre Channel adapter now costs about the same amount as a 10 GbE adapter (see Figure 8). With the cost per 10 GbE switch port dropping into Fibre Channel range, it will make sense to consolidate on a single data center network technology rather than maintain multiple parallel networks with separate administrators and management tools. In addition, all these physical network adapters and wires create a distinct server personality that makes them harder to reassign to different workloads that may be found in virtualized environments — some workloads might need lots of Fibre Channel SAN bandwidth, while others need only Ethernet. In order for virtual machines to be able to execute on any server, we'd have to provision all of them with an unnecessary number of Fibre Channel adapters so that we could support any workload on any machine.

Figure 8: 10 GbE Greatly Reduces the Number of Ports Required for a Server



***Converged Network Adapter (CNA)**

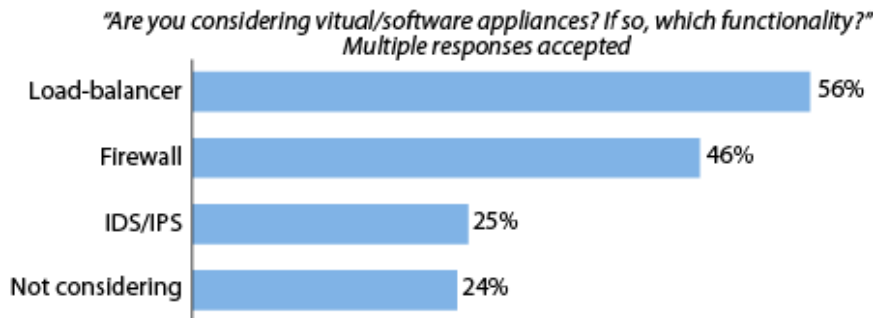
Source: Forrester Consulting, 2009.

By offering these virtualized network services over a single network architecture, you will be better positioned to scale up server virtualization. Why? Because virtualized network services can be extended all the way into the virtual machine. We can create virtual network adapters that appear to offer various kinds of Ethernet or Fibre Channel connectivity, but in reality everything would all run over the same network. Applications and operating systems get to have whatever flavor of I/O they were designed for, but we would no longer have to put up with the expense and complexity of running multiple networks. In addition, you would be able to solve the top two problems faced by our survey respondents:

- **Guaranteed end-to-end network performance.** By extending physical networks into the virtual realm through shared I/O, administrators would have end-to-end control of how much bandwidth is allocated to a given application. In addition to controlling quality of service, both virtual and physical network components could be administered by a single integrated management console.
- **VM-linked policies and configurations.** Virtual adapters within the virtual server environment could be linked to network policies in the real world. Since policies would be attached to a VM's virtual network adapter, network policy and configuration would follow VMs across physical servers or switches — avoiding configuration errors that result from static network configurations.

Shared I/O and high-speed fabrics provide the foundation for more dynamic data centers, but they are not the end of the story. In order for the network to become more dynamic — through shared I/O and VM-linked policies — we need management and network virtualization to complement them. The software powering our networks must mature to provide integrated virtual and physical networking. In today's world, the island of networking inside virtualization platforms has created organizational and technical management problems for IT. It is now clear that the virtual networks need to be integrated with and managed by our existing tools and procedures. Over time, this should also apply to all virtual network elements such as switches, load balancers, or firewalls. Just about any class of network equipment can be reinvented as a virtual appliance — and around half of firms we spoke with are already considering them (see Figure 9).

Figure 9: Respondents Find Virtual Web Infrastructure Appliances Appealing



Base: 204 IT and network decision-makers and influencers.

Source: A commissioned study conducted by Forrester Consulting on behalf of Cisco

Virtual Servers And Networks Unlock New Apps

Virtual servers have already resulted in new kinds of services because they make our application stacks more portable between dissimilar server hardware. As a result, we are now seeing the emergence of multiple types of cloud-based infrastructure. Some cloud providers will offer software-as-a-service — like email, collaboration, or sales force automation. Still others will provide virtualized servers that you can rent for hosting, disaster recovery, or capacity on demand. Because they can run our existing VMs, these new kinds of services are easy to turn on and off — something we would have never attempted with bare metal systems.

More broadly, virtual servers have changed the unit of work in the data center. They allow us to treat an entire server as a single unit that we can turn on, off, or move about. However, the first generation of virtualized cloud services is also imperfect, because although we can move a single VM into the cloud, it's much harder to move an entire service comprised of the VM plus its surrounding infrastructure systems into the cloud. This is where virtual networks play an important role in redefining the unit of work beyond a single VM.

Forrester believes that the combination of virtual servers and networks allows us to greatly expand the unit of work to encompass not just a group of servers running on one virtualization host but many such hosts — and all the network infrastructure between them. In other words, the new unit of work becomes the data center itself.

You've already seen data centers built inside cargo containers. If your current data center is flooded and you were provided a mobile data center in your parking lot, how long would it take you to "move in" and re-establish your data center operations inside of it? Even if you had virtual servers that could be immediately copied over, it would still take several days or more to get the network topology right. By virtualizing both servers and networks in an integrated way, Forrester believes that it will be possible to save the blueprint of your virtualized data center and redeploy it on new infrastructure. This blueprint would specify where your virtual servers reside and how they are connected to resources — making it possible to shift entire business services or data centers between your own infrastructure, cloud providers, and even into container-based data centers.

Appendix A: Methodology

In October 2008, Cisco Systems commissioned Forrester Consulting to investigate the role of networks in scaling workload virtualization initiatives beyond initial server consolidation efforts and how virtualization of network services themselves can complement these efforts.

In addition to leveraging existing research and data, Forrester gathered online survey data from November 10, 2008, to December 3, 2008, in support of its investigation. The survey asked IT executives about their enterprise server virtualization deployments or plans in the following areas:

- Current and future implementation timelines.
- Hardware and software virtualization architecture.
- Issues in managing virtualized environments.
- Virtualization barriers, benefits, barriers, and best practices.
- Return on investment and cost tracking.

Sample

The survey sample consisted of respondents from randomly selected organizations with 5,000 or more employees. In addition, all the respondents were required to meet the following criteria:

- IT or network decision-makers or C-level executives.
- Influencers of server virtualization architecture and networking decisions.
- Responsibility for technology selection, administration, or management oversight for virtual server environments.

Firmographics

We completed 240 online surveys among a random sample of IT professionals. Respondents to this survey all represented enterprises of 5,000 employees or more — 50% of which were very large enterprises of 50,000 or more employees — and 55% represented \$10 billion-plus revenue enterprises.

We set the following role responsibility quotas:

- 50 infrastructure architects.
- 50 enterprise architects.
- 50 VPs or directors of infrastructure.
- 50 network architects.