A Data Center Fabric Is Critical to a Next-Generation Unified Data Center

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Introduction: The Changing Data Center

The data center has gone through several major evolutionary changes over the past several decades, and each change has been defined by major shifts in computing. The industry moved from the mainframe era to client/server computing and then to Internet computing. In 2010, another major shift began—the shift to a virtual data center. The shift to a virtual data center will be the single biggest transition in the history of computing. This transition will reshape all the major data center tiers: applications, storage, servers and the network. The drivers of this transition are as follows:

- **Virtual machine (VM) mobility.** As organizations look to use virtualization more strategically, the virtual workload is evolving from a static resource that resides on a fixed computing device to a resource that is mobile and can be migrated, in real time, from server to server. Most current data centers are not architected to enable large-scale VM movement.
- **IT resource pooling.** To date, most of the focus of virtualization in the data center has been on servers. Over time, however, all the resources in the data center will become fully virtualized and "pooled" (see Exhibit 1 on the next page). This pooling will bring to fruition the vision of on-demand computing, in which any application or service can access as much of any resource it needs, governed by business policies. For cost/benefit reasons and to promote optimum utilization of existing resources, the ideal scenario is to create large, dynamically shared pools. These dynamically shared pools are driving the demand for a flexible data center architecture.
- **Cloud computing.** Moving and utilizing data center resources on an on-demand basis is a great concept. Cloud computing lets enterprises pay for only the resources they need, offloads much of the complexity of management and shifts IT spend from capex to opex. To capitalize on the value proposition of cloud computing, organizations need to architect the data center away from the current siloed model.

Every trend driving us toward a fully virtualized data center is highly dependent on the data center moving away from a number of vertically integrated silos and toward a fluid, dynamic "fabric" capable of moving IT resources where they are needed as the business dictates.

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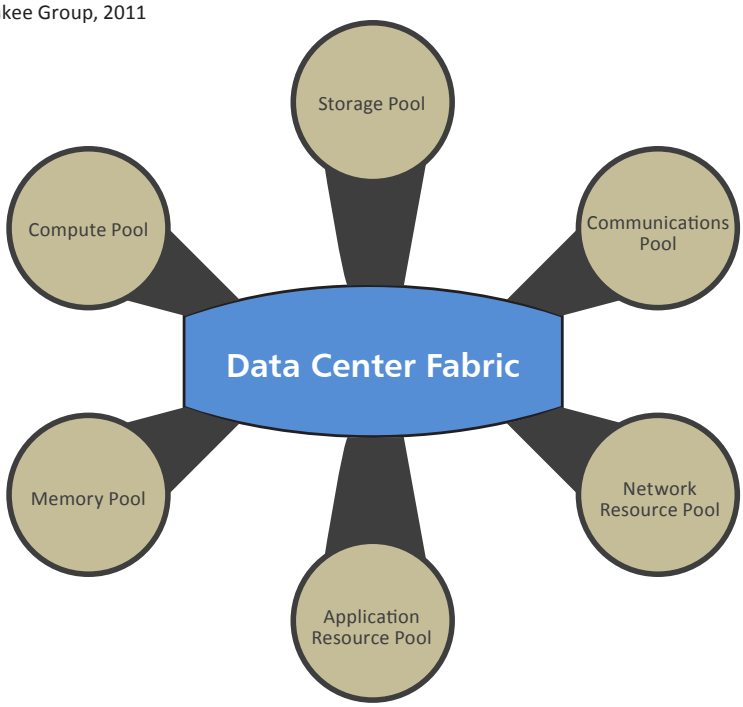
Exhibit 1: The Role of the Data Center Fabric
Source: Yankee Group, 2011



The Challenges of Legacy Data Centers

Legacy data centers were optimized for performance, not cost. Each application typically has its own dedicated network, storage and compute infrastructure. This means that each application has finite resources; it cannot use idle resources from any other application to improve performance. Over time, the siloed nature of the legacy data center has led to the following inefficiencies:

- **Poor resource utilization.** Deploying applications in silos means IT managers must provision all resources for peak utilization and then add a little more for overhead on the peak days, resulting in highly underutilized data center infrastructure. Based on ongoing research, Yankee Group estimates server utilization in a legacy data center environment is about 20 percent, while storage utilization is approximately 25 percent and network utilization is about 30 percent. Considering data center infrastructure is among the most expensive IT resource, this kind of waste is very costly.
- **Organizational structure not optimized for a virtualized data center.** IT infrastructure's vertically integrated nature has driven IT operations to be highly siloed as well. Each area of operations tends to work independently from one another. The resulting lack of cross-silo awareness can create situations where one area of operations makes a change and the other areas must scramble to adapt to it. This is one reason organizations spend an estimated 83 percent of their IT budget on simply maintaining the status quo.
- **Lack of agility to meet business demands.** Poor resource utilization combined with IT silos leads to long lead times in deploying the infrastructure required to deliver new applications and services. Typically, application owners must contact each area of operations independently for the needed resources, resulting in typical lead times of six to eight weeks for resourcing each part of a new application. In a worst-case scenario, an application may not be ready until approximately six months after the business asks for it.

- **High total cost of ownership (TCO).** Poor resource utilization, lack of agility and dedicated operational teams results in a lack of efficiency that drives the cost of running a data center to incredibly high levels. Almost every CIO's current mandate is to find a more cost-effective way of running the data center.

Clearly this legacy, expensive, inflexible way of running a data center will not put an organization in a position to leverage the trends of virtualization and cloud computing. Instead, organizations should look to a data center fabric.

Defining a Data Center Fabric

A data center fabric is a shared, integrated infrastructure platform capable of delivering application, storage, compute and network services where and when they are needed. The result of several major data center trends coming together to deliver a unified data center, data center fabrics offer organizations the ability to manage and orchestrate all the elements for physical, virtual or cloud-based deployments in a seamless manner. It helps dissolve both IT and organizational silos to increase efficiency, simplicity and business agility.

The data center fabric is more than just the cobbling together of data center infrastructure. The fabric needs to operate as a single system to deliver data center resources to any application or service as business policy dictates. To do that, the data center fabric must be:

- **Open.** No solution provider can deliver an entire data center. Being open is important to enable third-party integration across solution providers.
- **Integrated.** Traditional IT silos need to be integrated into a single fabric to ensure that the storage, compute and network resources can be optimized and maintained as the environment changes.
- **Flexible.** The application and virtualization environments the data center supports are not static, and the fabric can't be static either. Ultimately the business will only be as flexible as its data center fabric.
- **Scalable.** It's very difficult to predict the growth of compute, storage and network requirements. IT managers need to be able to scale up the data center fabric in real time to ensure there is enough capacity to deliver a high-quality experience to both workers and customers.
- **Resilient.** Today's business environments require non-stop operations. Downtime means lost customers, lost opportunity and lost revenue. The data center fabric needs to be built with resiliency and self-healing in mind to ensure maximum uptime with minimum disruptions.
- **Secure.** The data center delivers a wide range of information to applications and services, including data that is highly confidential and critical to the organization. Security is an area where data center architects simply cannot compromise.

Evolving the data center to a fabric may seem like a nearly impossible task, but it's necessary if an organization is to leverage the trends of virtualization and cloud computing and truly fulfill the vision of next-generation computing.

Benefits of a Data Center Fabric

Holistic data center fabrics offer many benefits. The most obvious is the simple consolidation of network, compute, storage and application resources. However, the value proposition is much broader. Other benefits of a data center fabric include:

- **Better utilization of data center resources.** A data center fabric virtualizes physical resources into logical pools. Instead of each application having its own set of IT resources, applications fetch needed resources from the logical pools. If more resources are needed, more is added to the pool. This optimizes IT resource utilization.
- **The breaking of IT silos.** The limitations of the current data center architecture drove IT into its current silos. A data center fabric allows for IT organizations to bring all the different operational silos under one common management area. This eliminates many redundant tasks and streamlines data center operations.
- **More productive IT staff and corporate workers.** Data center fabrics improve efficiency and create more manageable environments. This means less downtime for IT and less ad-hoc troubleshooting, leading to a more productive IT staff that is able to focus on strategic initiatives. Corporate workers are also more productive, since applications are more available and perform better.
- **Lower overall TCO.** Improved utilization means less hardware to buy, maintain, power and cool. Organizations that deploy a data center fabric will see a reduction in both operational expenses and capital costs, significantly reducing TCO.

Evaluating Data Center Fabrics

Moving to a data center fabric will be critical for almost every organization over the next five years. However, the term fabric is relatively new in network operations so it may not be clear how to evaluate solution providers. Key decision criteria for IT leaders considering moving to a virtualized data center include:

- **A holistic data center fabric.** "Fabric" is a widely used industry term. Choose a fabric solution that encompasses application, storage, servers and network infrastructure. Many vendors offer solutions in only one of these areas, but a data center fabric needs to address all the changing needs of a virtualized data center. Ideally, the fabric should provide a converged storage, server and network solution.
- **Scalability.** Data centers are not static entities; fabrics can't be static either. Organizations need the ability to start small, migrate at a comfortable pace and then expand the fabric as the data center grows. A lack of scalability could significantly hamper the value of the data center fabric.
- **Location-independent virtual resources.** Location-independent virtual resources provide the ability to deliver a consistent fabric experience, independent of whether the workload is in the same blade, within a data center or across data centers. Location-independence improves visibility, manageability and ease of use.
- **VM awareness.** The ability to move virtual workloads between servers, racks or even data centers is one of the many benefits of virtualization. However, moving virtual workloads can cause performance issues if the network, storage and computing policies are not coordinated. Data center fabrics must be "VM-aware," meaning they must be aware of every virtual machine and be able to track them as they move across the network.

Data Center Fabric Case Studies

The Organization: Apollo Group

Based in Phoenix and founded in 1973, Apollo Group is a provider of higher education programs for adults currently in the workplace. The University of Phoenix, Apollo's marquee university, has more than 400,000 students and 24,000 faculty members across its more than 200 campus locations and learning centers.

The Problem

Apollo Group's applications reside on 7,500 physical servers located in three interconnected data centers. Its data centers were architected in very typical legacy fashion: Each application had its own dedicated server, storage and network resources. Additionally, its network supported 1 Gbps speeds, again common for legacy data centers. Although this speed was sufficient five years ago, it's not workable today. The current architecture led to the following problems:

- **Poor user experience.** Apollo Group is seeing a significant increase in network traffic from applications such as video conferencing, Web sharing tools and social media. Students tend to expect any application will work anywhere on campus, whenever needed, but this was not the case. During peak traffic times, the network faltered, creating a sub-par experience for students. The organization became concerned that if experience did not improve, students would choose another online educator.
- **Long provisioning time for new applications.** Because each application had its own dedicated hardware, adding new applications required procuring new storage, servers and network resources. This created provisioning times that were less than ideal. For example, if a business unit were to request infrastructure for a new application, it would take two to four weeks to purchase and build the new servers alone.
- **Inconsistency in OSs and patches across servers.** Apollo Group's infrastructure experienced a significant amount of "drift," or inconsistencies in applications and OSs from server to server. This happens when a server or OS is patched or modified to react to an urgent condition, such as a security warning or business change. Too much drift can lead to intermittent outages and long troubleshooting times.
- **Lack of scalability.** Because each application or service was deployed in a dedicated silo, scaling the infrastructure meant having to staff up. Typically, doubling the IT infrastructure would require a 20-30 percent increase in IT staff.

The Solution

Apollo built its next-generation data center network on a foundation of Cisco Nexus switches. Apollo used a modular design to build out computing "blocks" that could be partitioned and provisioned as the business required. Each block contains a pair of Cisco Nexus 7010 switches at the core. The core switches are connected to Cisco Nexus 5010 or 5020 switches at the end of each row. The end-of-row switches are connected to Cisco Nexus 2248 Fabric Extenders deployed at the top of each rack. Each of the interswitch links use dual 10 Gig-E links, creating the high-speed, redundant network foundation needed to support the organization.

Apollo uses the Cisco data center fabric to create virtual data center "pods." A data center pod is a self-contained unit made up of physical/virtual storage, server and network resources that can be provisioned on an on-demand basis from a centralized management console. When a business unit requests infrastructure for a new application, a "pod" is created and assigned to the business unit. The allocation and provisioning of the storage, server and network resources is fully automated, removing the risk of human error that existed in the old, manual process. The virtualized compute resources deployed on the high-speed network foundation create a data center fabric. This fabric addresses all the technical challenges that could potentially keep the IT infrastructure from meeting the demands of the universities.

The Benefits

Apollo Group realized many benefits from its move to a data center fabric:

- **Greater agility to support business growth.** The data center fabric's modular design allows the IT department to respond to business units much faster. Prior to the fabric, the IT department could only provision one server at a time and, as mentioned earlier, it would take two to three weeks to complete the task. Now the infrastructure can be provisioned on the fly, giving IT the ability to create multiple servers simultaneously in minutes.
- **Lower infrastructure costs.** The Cisco Nexus 7000 Series switches have a port density that is 10 times greater than other comparable options. This combined with a flatter, fabric design ultimately means fewer switches to buy and less infrastructure to procure, manage, power and cool.
- **Reduced operational costs.** Since the Nexus 2248 switches are extensions of Cisco's 5000 Series switches, the IT department does not have to manage each 2248 switch individually. All management can be done on the 5000 Series switch, providing a single point of management. Apollo can now manage twice the number of devices with the same size IT staff. Eventually Apollo will actively monitor and automate more tasks with the Cisco Data Center Manager software to drive operational costs down further.
- **Improved user experience and application availability.** Legacy networks utilize a protocol known as Spanning Tree Protocol (STP) to prevent routing loops and broadcast storms. STP allows only one unique path for traffic at any given time, disabling redundant paths. When the primary path becomes unavailable, STP needs to recalculate and activate the next best path. In a large network like Apollo Group's, this process creates periodic downtime. The data center fabric removed the dependency on STP, increasing the overall uptime of the network. Additionally, the high-speed 10 Gig-E backbone ensures peak performance even during peak usage periods.

"The data center fabric built on a Cisco Nexus foundation allows our IT department to respond to the business units at Apollo Group in near real time," said Dennis Crowe, director of network engineering at the company. "The data center fabric has given us better uptime with an easier to manage infrastructure."

The Organization: NTT Data Corporation

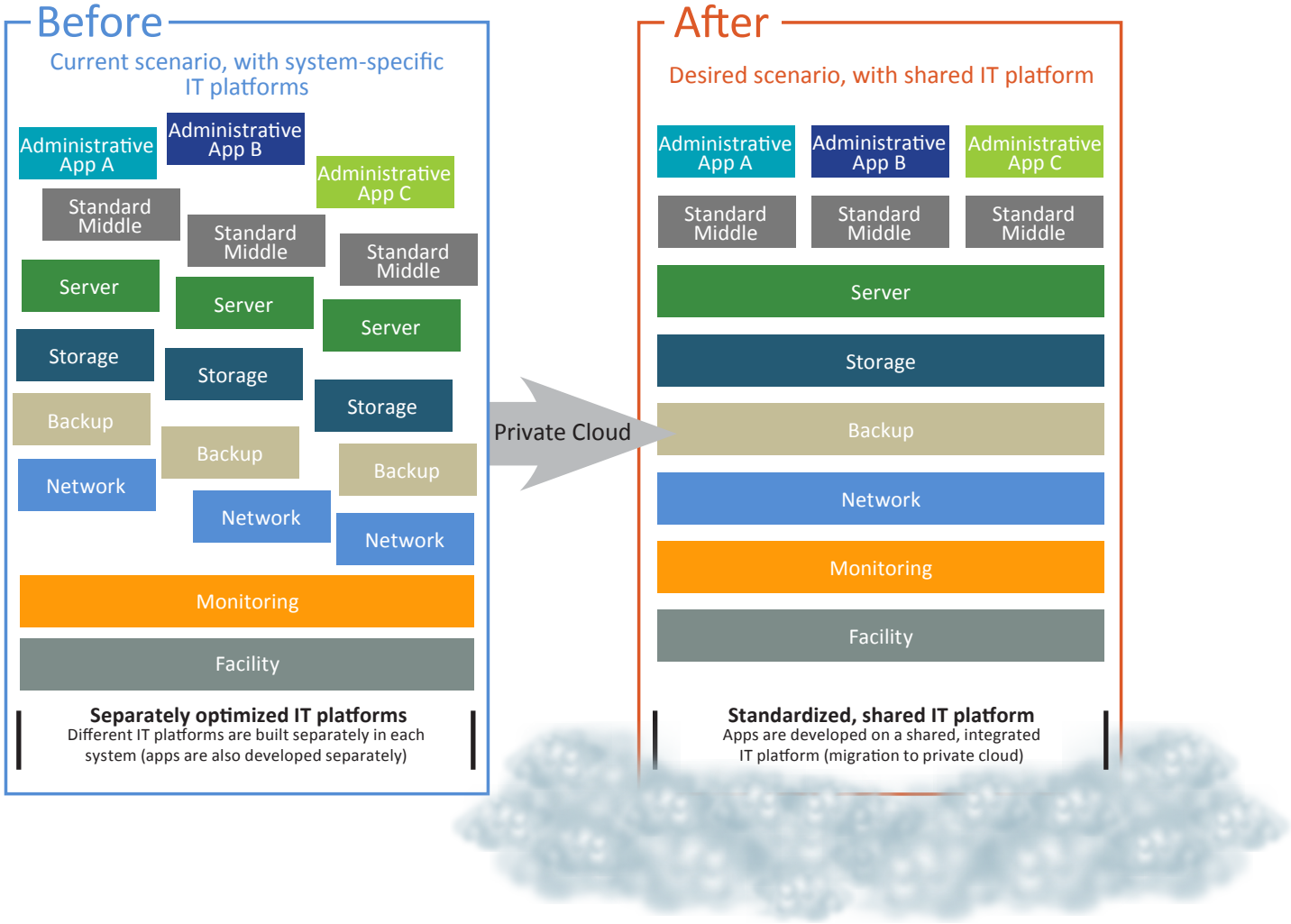
NTT Data is a global systems integrator with a successful track record of developing administrative systems as well as building and operating shared data centers. NTT Data owns more than 100 systems itself and is aggressive with its own IT strategies. NTT Data has bases in 145 cities and 34 countries, and it has a vision to be a global IT innovator.

The Problem

NTT Data's internal IT systems last had a major upgrade and redesign in 2006. The systems were facing problems of expiring hardware and software maintenance contracts, causing maintenance and management costs to skyrocket.

Historically, the company optimized its platforms in an ad-hoc manner, making them very difficult to manage. To better manage IT costs and make more effective investments, NTT Data decided to optimize its infrastructure using integrated virtualization. Its ultimate goal was to have a standardized, shared, companywide platform for all corporate applications (see Exhibit 2). In other words, NTT Data wanted its own private cloud where IT resources could be shared.

Exhibit 2: NTT Data's Vision of a Private Cloud
Source: NTT Data and Yankee Group, 2011



The Solution

To fulfill its private cloud vision, NTT Data implemented a data center fabric using Cisco's Unified Computing System (UCS), Cisco Nexus 7000 core data center switches, Cisco Catalyst 3560 and 2960 switches, Cisco MDS 9100 Fibre Channel Switches and Cisco ASA 5500 Adaptive Security Appliances.

NTT Data chose the Cisco solution for its data center fabric because Cisco offered functions such as service profile and fabric integration that allowed the company to streamline the development and operating phases of data center operations. In addition, the Cisco Data Center Fabric had the following benefits:

- **Simple system structure.** The Cisco UCS is optimized for architectural simplicity and the integrated system has far fewer elements than a traditional blade server. The network is delivered via the fabric interconnect so cabling is minimized as well. The storage network can also be integrated with the fabric so fewer SAN switches and cables are required. Also, NTT Data uses UCS Manager to manage the entire system, simplifying data center operations and reducing costs.
- **Network affinity.** To build a private cloud using integrated virtualization, reduced network complexity is a must. A Cisco data center fabric simplifies the network via fabric extender technology. This reduces the management points of the network and eases network interoperability.
- **Virtualization affinity.** The Cisco UCS hardware was architected to maximize virtualization's benefits. For example, it has virtual interface cards for controlling the quality of service (QoS) for each virtual network interface card (NIC). Additionally, the service profile function reduces the operational burden of installing and swapping out servers.

The Benefits

NTT Data's private cloud built on a Cisco data center fabric results in the following benefits for the organization:

- **Reduced TCO.** The total cost of running the environment is half that of the pre-installation level. Through integrated virtualization of servers and network integration using the fabric interconnects, NTT Data significantly reduced the number of hardware elements required. Compared to the previous system, initial investment was reduced by 58 percent, maintenance costs were lowered by 17 percent and rack costs were cut by 58 percent.
- **Shorter server provisioning time.** Central management of the servers combined with the use of the profiler function has increased operational efficiency. The provisioning lead times for servers was reduced by over 50 percent.
- **Greener data center.** The reduction of hardware components combined with other power-saving products has reduced carbon dioxide emissions by 79 percent, and NTT Data estimates that over a five-year period, the cumulative reduction in CO2 will amount to 3,540 tons.
- **Reference architecture for customer-facing services.** NTT Data is now using the lessons learned and the experience and expertise gained from this implementation to create its own total cloud service, BizXaaS, which it sells to its customers. This will enable the company to suggest customer-facing solutions with NTT Data as their innovation partner.

"Cisco UCS has the innovative system architecture optimized for a virtualized environment," said Masakazu Yamada, deputy manager for the System Engineering Business Unit and System Platforms Sector of NTT Data. "As such, we determined that UCS would maximize the TCO reduction resulting from this integrated virtualization."

Data Center Fabric Best Practices

Building a data center fabric involves more than just infrastructure. Organizations should follow best practices to minimize the risk and maximize the ROI of the technology deployment. Yankee Group recommends the following:

- **Build an agile infrastructure.** Traditional data center architectures are highly inflexible, difficult to scale and do not adapt easily to business changes. Building an agile infrastructure allows IT organizations to respond immediately to changes in the business climate, freeing IT from being the roadblock to competitive differentiation.
- **Converge all data center operations under one management leader.** While much of the focus of data center evolution has been around the rigid nature of the infrastructure, the organizational groups that support the operations are equally rigid. Converging all data center operations under a single management domain ensures the storage, application, network and server teams are working to a common goal and all changes are well-orchestrated.
- **Deploy a fabric that addresses storage, servers and network infrastructure.** The evolution to a virtual data center needs to span across servers, storage and the network. A next-generation fabric architecture needs to extend across all three domains. Migrating just a single area will significantly limit the benefits and ROI.

- **Automate as much as possible.** Human error accounts for the largest component of downtime in data centers today. Much of the cause is due to the fact that administrators need to perform repetitive tasks under tremendous pressure from the business, which leads to errors. The ability to automate and coordinate many of the tasks required to operate a data center can significantly increase availability, reduce the amount of downtime due to human error, and allow IT to respond faster and more accurately.
- **Strive for 100 percent virtualization.** Virtualization has been used extensively to reduce the number of physical servers in a data center. However, Yankee Group research estimates that only about 45 percent of workloads are virtualized today, with the majority being Tier 2 and Tier 3 applications. Virtualization technology has evolved rapidly over the past few years and now is capable of supporting even the most mission-critical applications. Additionally, having the workload virtualized provides a higher level of resiliency, since the VM can be moved between servers or data centers in real time. The goal for every organization should be to virtualize all workloads over time.

Conclusion

The industry is on the verge of another major computing revolution, this time to a fully virtualized unified data center. However, the path to the unified data center requires more than just using virtualization technology to consolidate servers. Applications, servers, storage and network infrastructure must work together to create an agile, flexible environment that can adapt to the short- and long-term needs of the business. A data center fabric is critical to supporting the journey to a fully unified data center and should be one of the most important initiatives for all organizations looking to gain a competitive advantage.

About the Author

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Zeus Kerravala is a member of Yankee Group's Affiliate Program. His areas of expertise include working with customers to solve their business issues through the deployment of infrastructure technology.

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