WHITE PAPER

Enabling Organizational Agility with New Campus Network Architectures

Sponsored by: Brocade

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July 2014

EXECUTIVE SUMMARY

The campus network is a critical component of an organization's overall network and information technology (IT) infrastructure. Because end users expect services to be delivered to their devices anywhere and anytime, with high performance and reliability, every link of the network becomes crucial for business productivity. This includes the vital last link to the user provided through the campus network. With new demands to support the proliferation of mobile devices, video and latency-sensitive streaming media, and cloud services and applications, there is greater pressure on the campus network and, by extension, the IT network administration team than ever before.

It is increasingly challenging to support the explosion of mobile devices and bandwidth-intensive applications and services with traditional three-tier campus network architecture models. With generations of "patch" technologies such as Rapid Spanning Tree and quality of service (QoS) to provide incremental improvements, these legacy campus network architectures tend to be static, complex, and inflexible, and because most changes require each component in the campus network to be individually reconfigured, it is difficult to roll out and support new applications and services.

Given these architectural limitations, much of the existing installed base of Ethernet switches, routers, and wireless access points (APs) and controllers in campus networks does not support the latest advancements and features required to manage the ongoing transformation in how applications are increasingly consumed in the enterprise. It would be extremely expensive to rip out and replace current-generation infrastructure, so IT departments need approaches that let them introduce innovative new functionality into the campus network in a way that is easy to implement and manage and that does not require forklift upgrades.

Brocade's portfolio of campus networking solutions, which provide the building blocks of the Brocade HyperEdge Architecture, supports the company's vision of "The Effortless Network" for the campus. The solutions, which include the Brocade ICX family of open standards-based switches, are designed to enable IT to deploy new network services and applications more quickly and easily while taking advantage of existing network devices. The HyperEdge Architecture approach optimizes wired and wireless device interoperability by flattening the network and removing legacy protocols such as Spanning Tree. The result is a flexible and agile network that provides a foundation for rapid application deployment and simplified management and significantly lowers operational costs.

This approach enables IT to meet the changing requirements of its user base more quickly, more easily, and more cost effectively to ensure overall business productivity today and tomorrow.

As an early-stage evangelist and innovator in SDN technology evolution, Brocade offers end-to-end OpenFlow support across its entire portfolio of datacenter and campus switches. Today, HyperEdge Architecture delivers network simplicity advantages that will easily integrate with future SDN automation applications and controllers in the future.

SITUATION OVERVIEW

Campus Networks Are Vital Links Between Business and Customers

Key Trends Impacting the Campus Network

Information technology continues to transform the economic landscape, and businesses rely on their networks for a growing number of functions that are critical to ensuring financial and operational success. Organizations are deploying new applications and supporting a proliferation of new devices across the network, and there are increasing demands to deliver advanced application services closer to the network edge. The campus network is the critical link between users and the servers delivering these applications, and supporting new features on legacy campus architectures requires significant capital expenditures (capex) to upgrade the network infrastructure, which in turn increases management complexity and operational expenditures (opex).

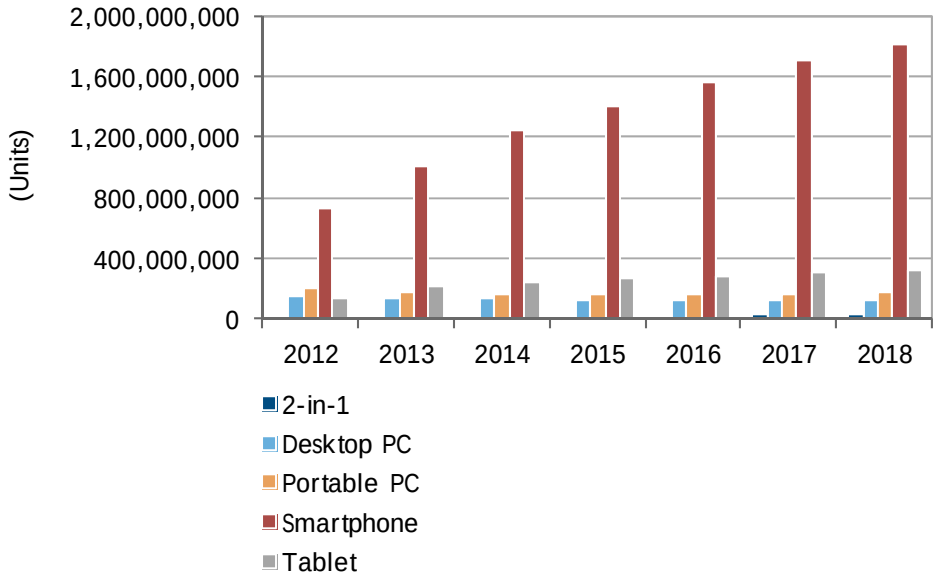
New requirements for the campus network include support for the explosion in smart mobile devices running rich media (streaming video and audio) and virtualized, cloud-based applications. While the introduction of these technologies creates opportunities for employees and the enterprise, it creates challenges for the IT organization and for the network administrator.

Growth in Mobility and Bring Your Own Device

The enterprise is being transformed by the introduction of technologies and products originally designed for consumer use cases and applications. One aspect of this trend is the growth in the number of employees using mobile devices for work purposes. This includes employee-owned mobile phones and tablet devices (iPads) in addition to traditional laptop PCs (see Figure 1).

FIGURE 1

Worldwide Smart Connected Device Shipments, 2012-2018



Source: IDC's Worldwide Smart Connected Device Forecast , 2014

In many cases, these devices are employee owned or purchased. This "bring your own device" (BYOD) trend is evident in a number of IDC studies. For example, a recent IDC study found that 79% of enterprise mobile devices are employee owned (BYOD) – up significantly from 45% in 2010. Further, an increasing number of these devices, such as tablets and smartphones, are wireless only, with no ability to connect to a wired infrastructure. Of course, because these devices are being used for personal and work purposes, the use of social and virtual applications on these devices continues to increase, irrespective of where the devices are used. And when they are used within the campus, the impact on the underlying network and IT infrastructure cannot be overemphasized. IT managers, however, do agree that the current consumerization trend is strategic to IT, and as such, it can be leveraged for quantitative and qualitative benefits to the enterprise.

While the use of mobile devices has made employees, as well as corporations, more productive, IT departments are struggling to support the devices while maintaining control of their infrastructure. The question is no longer if IT accepts smart mobile devices on the enterprise network but how it supports, manages, and secures them while providing an appropriate user experience for application access. Challenges include the need to set up identity and access control policies and to develop network strategies for managing unpredictable and sometimes stringent connection requirements.

Increasing Video, Unified Communications, and Client Virtualization

The use of video collaboration in the enterprise is starting to become nearly as ubiquitous as other means of communication such as email and, of course, voice communications. Consumers and businesses are making greater use of the Internet to access rich content media, including streaming

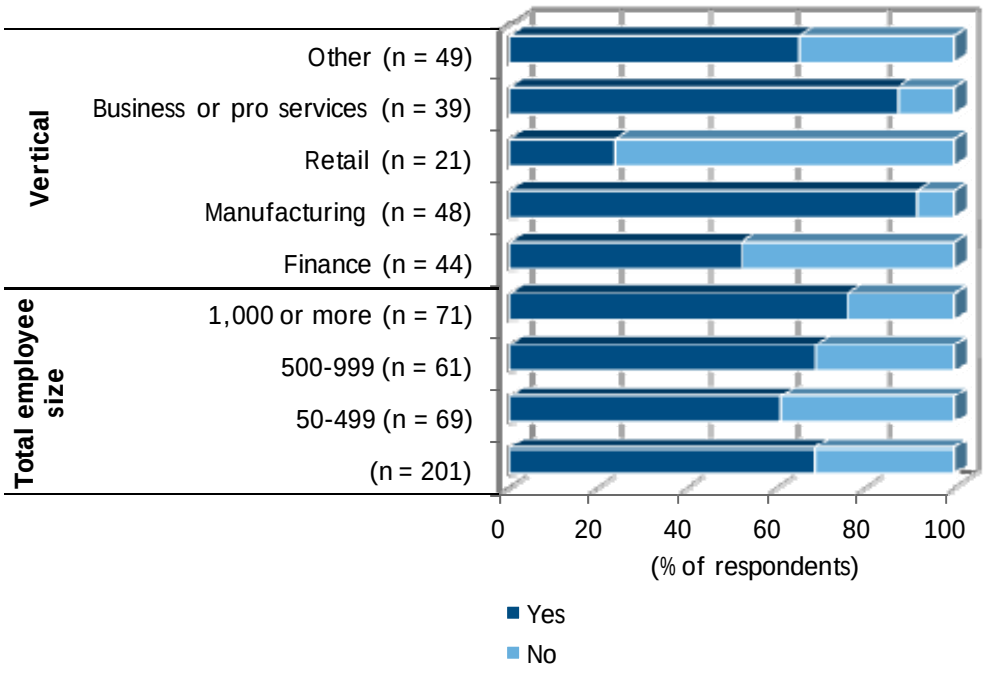
audio and video, and virtual desktop infrastructure (VDI) to host users' desktops within a centralized virtual environment. Collaboration services such as email, Web conferencing, and unified messaging now incorporate video. In a recent IDC survey, over one-third of all organizations reported that they currently use some type of video, such as desktop videoconferencing or telepresence, and one-third indicated that they plan to do so within the next one to two years.

The virtual desktop is another area that is seeing increased traction within IT environments, and IDC expects that the worldwide desktop virtualization market will exceed $3 billion in revenue in 2014. One of the key factors influencing adoption is the cost savings that accrues via centralized administration and management of distributed systems. Automation of desktop upgrades certainly provides a compelling argument, but the security and reliability of VDI are also driving IT to take another look at client virtualization. And that's where the campus network becomes the vital link, enabling communication and collaboration both across and outside the enterprise. Figure 2 shows that client virtualization, a technology that spans a spectrum of wired and wireless devices within an enterprise, has reached widespread adoption across enterprises of varying sizes.

FIGURE 2

Client Virtualization Usage

Q. Does your company use client virtualization technologies?



Source: IDC's Virtualization Study, 2014

Clearly, campus networks need to adapt to handle the growth in media-rich content and other applications, as discussed previously. These applications place greater demands on the network architecture not only because of their raw bandwidth requirements but also because they must provide the low latency and high application performance that users expect. To support these applications, the network must be designed for efficient communication and incorporate advanced features such as QoS, multicast video streaming, and traffic shaping.

Cloud Services

Cloud computing allows IT organizations to reduce complexity in their environment, ease the workload of internal IT staff, and reduce the number of skills required in their organization. It can help IT departments more rapidly scale their compute resources to more flexibly adapt to changing business requirements.

IDC has seen significant growth in cloud computing. Worldwide revenue from public IT cloud services exceeded $21.5 billion in 2010 and will reach over $70 billion in 2015, representing a compound annual growth rate (CAGR) of over 25%. This rapid growth is over four times the growth projected for the worldwide IT market as a whole (6.7%). A significant part of the growth in cloud is expected to come from private cloud rollouts, as enterprises start to see the value of implementing complementary approaches of cloud — public and private.

Cloud services are being used to deliver a wide variety of business-critical workloads that drive a company's interactions with customers, partners, and suppliers as well as key internal business processes. Businesses cannot afford for these workloads to go down or be inaccessible for any reason, including the network — irrespective of whether the fault is with the cloud provider's network or the enterprise's internal network. With more and more cloud services being accessed across campus networks, the architecture needs to be better aligned with the business applications and provide the foundation for efficient and reliable application access to ensure optimal user productivity.

Enabler of Rapid Application Delivery and Business Agility

As more and more users become dependent on services delivered over the network, supporting an agile and resilient campus network is crucial to business productivity. The campus network is not only the vital link through which knowledge workers access critical applications but also a potential bottleneck if those applications cannot be delivered with the performance required.

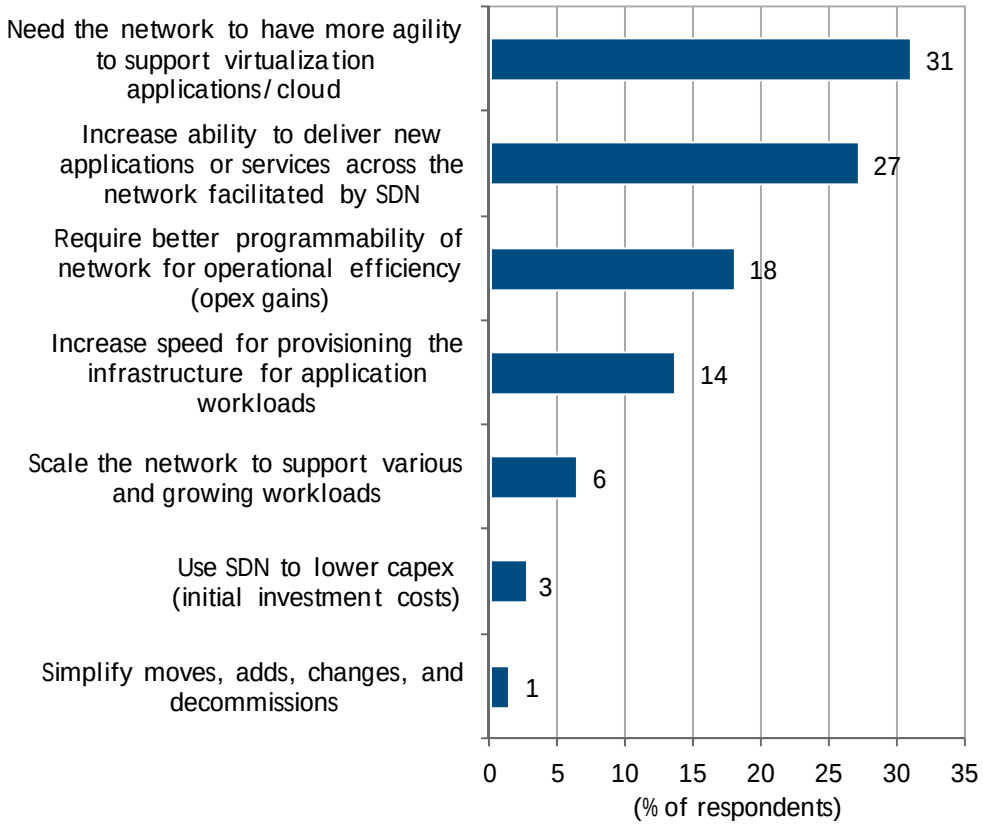
Delivering each new application and service requires investment in the campus network. It is no longer sufficient to architect the network to provide high levels of automation and simplification in the virtualized datacenter while relegating the campus network to second-class status. In fact, IT managers are aware of the limits of their existing networks. According to IDC research, over 20% of IT managers note that their networks are not well suited for making changes and lose resiliency when doing so.

Now that IT is on the front line of the business, every network connection is that much more critical. Enterprises must implement campus networking solutions with high levels of agility and automation to support an increasingly mobile and demanding workforce. One way in which enterprise IT is doing this is through the implementation of SDN solutions. A recent IDC survey of enterprise IT professionals showed that agility was the most cited primary motivation for either considering or implementing SDN solutions (see Figure 3). In fact, one of the primary drivers of the evolution of SDN has been the enterprise's desire to bring more agility to the network in both the datacenter and the campus.

FIGURE 3

Motivations for Considering SDN

Q. Which of the following factors are the primary motivation for considering or implementing SDN?



n = 362

Source: IDC's *SDN Survey,* 2014

Constrained Budgets and Staffing Challenges

Unfortunately, all of this is playing out against the backdrop of constrained IT budgets and staffing challenges. Even though the IT infrastructure is the backbone of most enterprises, organizations have limited IT budgets and are being asked to do more with less. Their ability to invest large sums in network upgrades, maintenance, and installation is usually limited. Organizations are spending much of their time and budget just keeping the existing infrastructure running.

IDC surveys of and conversations with IT executives continue to demonstrate this issue. A recent IDC study of IT managers showed that more than three-quarters (76.8%) of staff time is spent maintaining the environment and less than a quarter (23.2%) is spent on value-added activities.

To meet these challenges, enterprise IT needs to find solutions that deliver immediate value both today (e.g., by providing low capex and simplified provisioning) and over time (e.g., by providing reduced opex through automation and investment protection). Further, organizations must be able to deploy the solutions using a phased approach, thus avoiding the need for a rip-and-replace approach when updating their infrastructure.

REQUIREMENTS FOR THE CAMPUS NETWORK

These trends, in combination, create a need for networks that are more flexible and transparent. They must be more agile and easier to manage, introduce greater degrees of automation, and enable cost-effective deployment, maintenance, and delivery while protecting the current campus network investment.

- **Flexibility to support advanced network services.** To ensure organizational agility, the network must have the flexibility to support new applications and services as needed, including mobile devices, video, and cloud. This requires the availability of advanced Layer 3 services such as virtual router forwarding, tunneling, multicast video streaming, or IPv6 all the way to the edge. Campus networks must be architected such that they are neither a hindrance nor a bottleneck to business units looking to introduce new applications or further embrace mobile users and devices.
- **Simplified deployment.** To support organizational agility, the network architecture must enable simple deployment and provisioning of new applications, services, and features without requiring administrators to reconfigure the network or touch every device.
- **Investment protection.** The architecture must support the introduction of network services and features onto existing hardware without requiring administrators to rip and replace the current network infrastructure to meet changing business needs.
- **Simplified, ongoing automated management.** Because organizations are managing increasing complexity in the network with limited budget and staffing, they need advancements that ease the management burden to better ensure uptime and security.
- **Cloud readiness.** The ability of individual managers and business units to obtain access to compute resources via public cloud from a third-party provider, or in a public/private model from the enterprise datacenter, increases the need for performance and reliability from the campus network.

- **Reliability.** Because of its business-critical nature, the campus network requires a fault-tolerant and high-performance network architecture that takes into consideration the front-office applications now running on the network. To accommodate this, campus networks require high degrees of reliability, performance, and fault tolerance.
- **Open.** To support long-term growth as SDN applications begin to deliver new levels of network agility and flexibility from the datacenter through to the campus LAN and WAN, open technology, protocols, and APIs continue to grow in importance.

REMOVING THE CAMPUS NETWORK BOTTLENECK: PRAGMATIC APPROACHES TO NETWORKING CHALLENGES

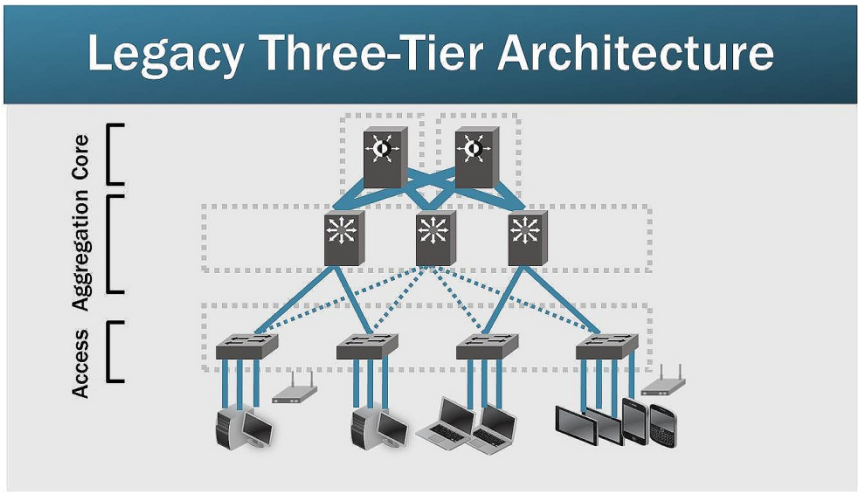
Traditional Three-Tier Architectures Can Be Inflexible and Inefficient

Because of their crucial nature and their role in enabling business productivity, enterprise applications require uninterrupted connectivity, high availability, and peak performance during high traffic demand periods at the network edge. As an enabler for these vital applications, the network must now be architected with the flexibility to quickly deliver new applications and services as the organization requires them, all the way out to the campus wireless edge – whether a conference room, a lab, or a courtyard.

Unfortunately, traditional three-tier architectures for campus networks, built primarily as static deployments for client/server models, can be inflexible and inefficient, especially when supporting wireless users. Figure 4 shows a traditional architecture consisting of core, aggregation, and access layers. In this approach, traffic is typically routed between the aggregation and core layers using Layer 3 protocols, while traffic between aggregation and access layers is switched using Layer 2 protocols such as Spanning Tree.

FIGURE 4

Traditional Three-Tier Campus Network Architecture



Source: Brocade, 2014

This approach is inflexible, has high opex costs, and is inefficient for campus environments. There are more network devices and connections than necessary, and the need to run Spanning Tree for loop detection limits port utilization from running at full capacity. The approach is expensive due to the large number of devices — usually a combination of modular and fixed — that must be purchased, deployed, and managed.

THE NEED FOR A UNIFIED WIRED/WIRELESS ARCHITECTURE AND STRATEGY

The campus network must provide a holistic, unified infrastructure for application delivery regardless of whether applications are delivered over wireline or wireless connections. Users are increasingly using wireless-only devices and must have a common set of procedures and protocols for accessing the network and applications, and administrators should have a single consolidated set of network management tools and policies that span both wired and wireless access points.

Most campus networks treat wired and wireless network components as distinct "siloed" deployments with little integration or optimization between the two. This often comes with the burden of supporting two different management platforms and security policy implementation tools, causing overall management complexity and the possibility of human error while synchronizing the disparate platforms. Users should have the same user experience whether they enter the network through a mobile or wired device.

Supporting Peer-to-Peer Wireless Communications

Just as datacenter networks have evolved to support increasing server-to-server traffic (i.e., east-west traffic), so the campus network is evolving to support peer-to-peer and often wireless-only communication. Users wish to physically move from one campus location to another, and they increasingly do so without connecting to the wired network. For example, corporate users frequently unplug from their desktop network and move to conference rooms to host online meetings while wirelessly connected. Online collaboration applications are typically bandwidth intensive and QoS sensitive and put voice and data traffic on the wireless and wired campus network. Given that the campus is the gateway through which users collaborate and communicate, it is imperative to seamlessly implement an efficient wired and wireless architecture that ensures low latency and a high-quality user experience on the campus — not just in the datacenter.

Ease of "Living with the Network"

As the campus network becomes an increasingly important enabling tool for application delivery to the network edge, it must provide application access without adding management complexity and operational costs. The campus network must allow for easier deployability, manageability, and scalability and greater flexibility when expanding network capacity while also making it easier and faster to deploy the applications that are so crucial to business productivity.

BROCADE'S SOLUTION

Brocade HyperEdge Architecture

In 2012, Brocade introduced "The Effortless Network" vision, which enables organizations to deploy resilient and high-performing networks that are simpler and more automated. This vision is embodied in the Brocade HyperEdge Architecture, underpinned by Brocade ICX campus switches and open standards-based mobility and SDN. Brocade has deployed its ICX campus products in over 5,000 customer sites, including commercial enterprises, government agencies, service providers, healthcare providers, and educational institutions.

The HyperEdge Architecture represents an evolution of Brocade networking technology that relies on the use of distributed HyperEdge Domains to simplify networks by eliminating legacy protocols such as Spanning Tree. A HyperEdge Domain is a group of network switches that enable distributed services, consolidated management, and shared network configuration information and is designed to integrate seamlessly with legacy campus network architectures.

Key HyperEdge Architecture features include:

- **Distributed services.** Premium and entry-level switches can be mixed in a single HyperEdge Domain through mixed stacks, where the advanced features and services of the premium switches are propagated to all switches in the stack, including entry-level switches. This capability reduces per-port costs to implement the latest networking services and ensures investment protection.
- **Consolidated management.** The HyperEdge Architecture enables configuration and management of all HyperEdge Domain switches as a single logical unit so that network services and policies can be applied once and then automatically propagated to all switches within the HyperEdge Domain.
- **Active-active interconnections.** This method for connecting multiple HyperEdge Domains increases scalability, expands the forwarding domain, and provides seamless integration into existing campus networks to ensure the shortest path forwarding at Layer 2 and Layer 3.
- **Distributed scale-out chassis**. This method of deploying high-density 10G/40G stackable switches for the campus aggregation and small core delivers higher performance and port density than a traditional midsize chassis while offering the same level of reliability and availability. These stackable switches can be distributed and spread over the entire campus —through the use of long-distance optical links — but the system as a whole can be managed as a single entity.

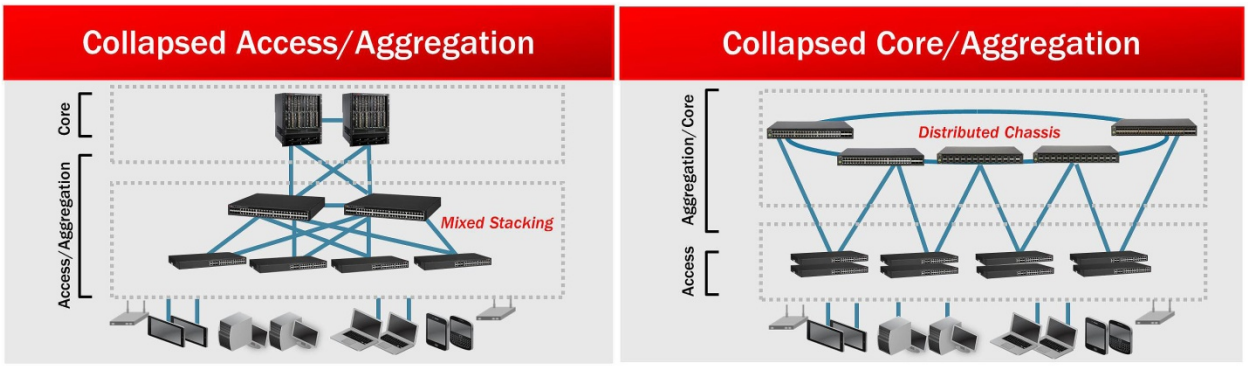
In contrast to a traditional three-tier approach, the Brocade HyperEdge Architecture offers flexible deployment options that utilize a simplified two-tier approach to reduce management complexity and operational costs. The aggregation layer is removed and collapsed into either the access edge of the network or the core routing layer. This allows consolidated management of the new combined network layers previously managed as distinct domains in traditional three-tier designs (see Figure 5). The combined aggregation/access layer is created by leveraging the distributed services feature of mixed stacks while the combined core/aggregation layer leverages high-density 10G/40G stackable switches with advanced Layer 3 routing capabilities to replace restrictive chassis systems. By completely removing one of the physical layers, the HyperEdge Architecture reduces the number of devices that

need to be purchased and maintained. It supports a Layer 2/3 multipath environment with all links active and provides loop protection without the need to run Spanning Tree, reducing complexity and enabling each device and network connection to be utilized more fully. This simplifies deployment, flattens the network, and reduces capex and opex costs because there are both fewer boxes in the network and fewer touch points for network management.

These combined layers can be configured in a number of ways, such as ring or star configurations. The HyperEdge Architecture supports integration of domains so they look like a single, flat Layer 2 domain. All links are active-active up to the core router, providing high levels of failover and high degrees of scalability and resiliency with greater management simplicity and less to manage.

FIGURE 5

Brocade's HyperEdge Architecture Two-Tier Deployment Options



Source: Brocade, 2014

Advantages of the HyperEdge Architecture

Key benefits of the HyperEdge Architecture for campus networks include simplified deployment and management, flexible scalable growth options, and open standards interoperability.

Simplified Deployment and Management

Traditional three-tier architectures are typically static and inflexible. In contrast, the HyperEdge Architecture supports greater levels of agility and responsiveness by speeding application deployment with common network and security enforcement across a simplified two-tier design.

The HyperEdge Architecture eases the network administrator's burden by consolidating management and reducing the number of management touch points. Traditional three-tier architectures require extensive configuration, including enabling routing functions, setting up OSPF areas, and defining LAG groups. But with the HyperEdge Architecture, all ports in the HyperEdge Domain are managed from a single master switch. This means that all routing and configuration changes, LAG groups, and VLANs can be set up once and automatically propagated to all devices in the HyperEdge Domain.

This approach not only makes it easier to set up the network but also makes applications easier to deploy. For example, setting up a new VLAN in a classic three-tier architecture is a tedious process in which every box that touches the VLAN needs to be configured individually. With the HyperEdge Architecture, the administrator simply configures the master switch, and the configuration is propagated automatically to all clients in the virtual switch, lowering installation and deployment time.

Flexible Scalable Growth Options

HyperEdge Architecture features such as distributed services and distributed scale-out chassis significantly enhance the capabilities of the network manager to scale network services and port density easily while protecting the existing network infrastructure investment.

Distributed services enable advanced network features to be shared between premium and entry-level switches through mixed stacks deployed as network needs change. Simply adding premium switches to an existing entry-level stack allows all switches within the stack to inherit the advanced features of the premium switches. By contrast, alternative network switch providers would require a complete rip and replacement of existing switches to achieve equivalent premium services functionality across all ports.

Distributed scale-out chassis allows the network architect to easily add incremental network aggregation and core layer density when and where needed. Brocade high-density 10G/40G stackable switches deliver the benefits of chassis solutions with single-point management and hitless failover reliability but also offer a lot more flexibility with a "pay as you grow" acquisition model and can be deployed exactly where they are needed on the campus. In addition, stackable switches are significantly less expensive to acquire and to operate than equivalent chassis switches.

These features allow organizations to buy only what they need today, whether upgrading a single building or single floor, and add to the network as necessary later without having to worry about their upgrade path.

Open Standards–Based Interoperability

The HyperEdge Architecture is based on open standards and ensures multivendor interoperability to give network managers the freedom of choice to take full advantage of new network industry innovations such as SDN or best-of-breed solutions to address the integrated wired wireless network.

SDN has become a key enabling technology of the HyperEdge Architecture. OpenFlow, running on Brocade switches, can either affect all traffic on a given link or work in tandem with traditional protocols that utilize the Brocade hybrid per-flow mode. This enables manipulation of specific flows on a link while letting other flows utilize the normal packet processing pipeline. Brocade is standardizing on OpenFlow version 1.3 end to end across its entire switch and routing portfolio — with the associated increased functionality, high availability, and security capabilities — for a robust enterprise from the datacenter to the campus edge and through the wide area network. This will enable Brocade customers to take full advantage of new industry SDN controllers and applications as they emerge to address the historical limitations of legacy networks.

HyperEdge Architecture has also been optimized to work with a broad range of ecosystem partners spanning mobility, NAC, and firewall multivendor services. As an example, Brocade developed a strategic partnership with Aruba Networks to provide integrated management and security policy enforcement across the wired and wireless network infrastructure. Both companies have engaged in joint engineering development resulting in integrated releases of Aruba AirWave, Aruba ClearPass, and Brocade Network Advisor that support the combined portfolios of both companies. Brocade ICX switches are fully supported by the Aruba AirWave management platform while Aruba APs can be managed from Brocade Network Advisor. In addition, Aruba ClearPass NAC supports integrated dynamic context-aware security policy enforcement across a joint Brocade switch and Aruba wireless deployment.

OPPORTUNITIES/CHALLENGES

Opportunities include:

- **Establishing a leadership position in the campus networking space.** Brocade has not traditionally been a top-of-mind vendor for many customers considering options for campus networks. By coming to market with a flexible architectural approach, Brocade offers improved deployability and greater levels of manageability and control. This also enables the introduction of cost-effective enterprise-class network functionality with increased security and stacking bandwidth, allowing Brocade to carve out a unique position in the midrange segment of this market.
- **Leveraging the breadth of its campus offerings.** By offering a complete family of switch and router products from the edge to the core optimized for interoperability with multivendor mobility and SDN deployments, Brocade can continue to differentiate itself in this market.

Challenges include:

- **Demonstrating credibility and educating the market on the new positioning.** To continue to improve its competitive positioning as a credible player in enterprise-grade campus networking technology, Brocade will have to demonstrate how its technology provides unique, cost-effective capabilities in campus networking and will have to show customers some of its successful deployments and the business and IT benefits they have achieved.

CONCLUSION

The campus network is a vital component of the enterprise network and the primary link through which users access applications and network services. Organizations must ensure that they have cost-effective, flexible approaches to their campus network that ensure organizational agility and scalability and are easy to manage.

Brocade has developed an innovative approach to campus networking with its HyperEdge Architecture. This holistic approach allows the introduction of advanced network services and scale by simply adding new switches into existing network infrastructure without forklift upgrades. The HyperEdge Architecture flattens the network, reduces network management complexity, and reduces

operating costs while enabling IT departments to respond more quickly and with more flexibility to meet changing user application and mobility requirements.

Based on open standards and emerging SDN protocols, Brocade customers will be able to take full advantage of best-of-breed multivendor solutions and new industry SDN controllers and applications to address historical limitations of legacy networks.

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