Overview

Cisco Data Center Network Architecture and Solutions Overview

EXECUTIVE SUMMARY

The Cisco® Data Center Network Architecture, based on Cisco's enterprise-wide Service Oriented Network Architecture (SONA) provides a cohesive foundation for IT executives to better align data center resources with business priorities. The architecture allows IT organizations to achieve lower Total Cost of Ownership (TCO), enhanced resilience and greater agility by evolving data center infrastructures through consolidation, virtualization, and automation.

Lower TCO

The Cisco Data Center Network Architecture optimizes IT productivity and resource utilization by providing a platform for the secure deployment of a service oriented, on-demand model for compute, storage and network resources. It offers customers greater choice for scale-up and scale-out server and storage consolidation and virtualization strategies, resulting in lower capital costs and higher utilization. It allows reduced operations costs by streamlining management and provisioning of pooled infrastructure resources to meet application needs. IT departments can take advantage of validated design best practices, data center support services and pre-qualified partner solutions to simplify implementation and reduce deployment costs.

Resilience

The Cisco Data Center Network Architecture creates an environment to protect valuable applications, services, information and infrastructure. It helps to ensure regulatory compliance by providing a resilient network infrastructure that supports security, availability, performance and business continuance goals. By providing end to-end segmentation across network, server and storage environments, together with application delivery optimization services, Service-Level Agreements (SLAs) are improved at the same time that the benefits of consolidation are realized. The extension or replication of server, storage and application environments across geographically dispersed data centers ensures continued service even in the case of major disruptions.

Agility

The Cisco Data Center Network Architecture facilitates the adoption of new IT strategies, such as Service Oriented Architecture (SOA), Virtualization and On-Demand Computing that allow organizations to respond faster to changing needs. Cisco's vision for the evolving data center is to create, together with other industry leaders a virtualized infrastructure that has the ability to respond quickly to new application demands, service requirements, attacks or disruptions based on pre-defined policies.

The Cisco Data Center Network Architecture includes:

- *Networked Infrastructure:* Gigabit/10Gigabit Ethernet, Infiniband and Fibre Channel switching on Intelligent Server Farm, Server Fabric and Storage Networking platforms and DWDM, SONET and SDH Optical Transport platforms
- *Interactive Services:* Storage Fabric Services, Compute Services, Security Services, and Application Delivery and Integration Services
- *Management Framework:* Configuration, Security, Provisioning, Change and Fault Management Services

Cisco Service Oriented Network Architecture (SONA) for the Evolving Data Center

DATA CENTER CHALLENGES

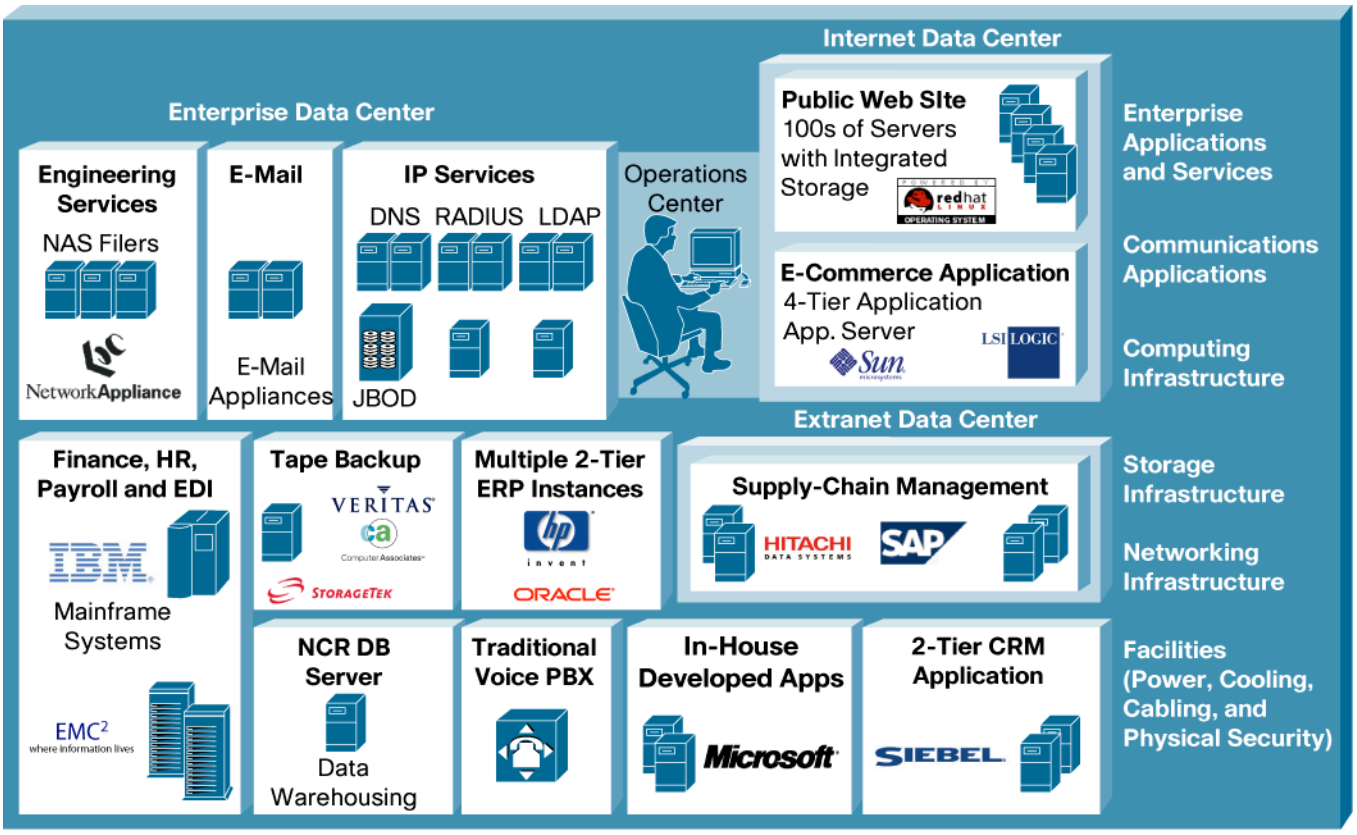
The heartbeat of any organization is in the data center. Employees, partners, and customers rely on data and resources in the Data Center to effectively create, collaborate, and interact. Over the last decade, the rise of Internet and Web-based technologies has made the data center more strategic than ever, improving productivity, enhancing business processes, and accelerating change. Data centers are the strategic focus of IT efforts to protect, optimize and grow the business.

Data center managers face several challenges in fulfilling these goals. Most enterprise data centers grew rapidly to meet the explosive economic growth of the previous decade. Consequently, applications commonly stand alone in underutilized, isolated infrastructure silos. Each infrastructure silo is designed based on the inclination of the specific application being deployed, so that a typical data center supports a broad assortment of operating systems, computing platforms, and storage systems. The disparate infrastructures supporting different application “islands” are difficult to change or expand and expensive to manage, integrate, secure, and back up (Figure 1).

According to industry estimates, more than 70 percent of IT budgets are dedicated to sustaining existing application environments. Therefore, IT organizations must improve operational efficiency, optimize utilization of data center resources, and release funds for innovative new IT projects that help generate revenue. Data center managers need a resilient infrastructure that consistently protects diverse applications and services against disruptions and security attacks.

The ultimate goal is an agile infrastructure that can incorporate ongoing improvements in computer, storage, networking and application technologies, and empowers IT to support changing business processes. Using consolidation and virtualization technologies, Cisco Data Center solutions enable IT organizations to turn computing and storage resources from monolithic systems into a "service-centric" shared pool of resources consisting standardized components that can be dynamically aggregated, tiered, provisioned, and accessed through an intelligent network.

Figure 1. Isolated Application Environments Result in Operational Inefficiencies



THE CISCO DATA CENTER NETWORK ARCHITECTURE

The evolving consolidation and virtualization of data center resources requires a highly scalable, resilient, and secure data center network foundation. The network is the fabric that provides secure user access to data center services and an infrastructure for the deployment, interconnection and aggregation of shared data center components as required, including applications, servers, appliances, and storage. A properly planned data center network protects application and data integrity, optimizes application availability and performance, and enables responsiveness to ever-changing market conditions, business priorities, and technology advances.

The Cisco Service Oriented Network Architecture (SONA) framework outlines how enterprises can evolve to an Intelligent Information Network that optimizes applications, business processes and resources. Cisco SONA is based on the principle that by making the right investment in the network, an enterprise can dramatically increase productivity, efficiency and business resilience, reduce costs and improve IT alignment with business priorities. Nowhere is this more true than in the data center.

The Cisco® Data Center Network Architecture, based on SONA, provides IT organizations with a framework to address IT organization immediate data center demands for consolidation and business continuance, while enabling emerging service-oriented architectures, virtualization, and on-demand computing technologies, within the context of an architectural approach. The architecture presents IT managers with greater choice and freedom to deploy compute, storage and software technologies that best support their business goals. Cisco helps IT managers adopt this architecture to reduce risk, time, and investment with tested and validated reference architectures, proven design best practices, and both generic and partner-specific configuration templates.

The Cisco Data Center Network Architecture allows businesses to protect critical applications and confidential data, enhance data center operational efficiencies, and rapidly create new secure application environments to support new business processes. The architecture allows businesses to invest more resources in IT initiatives that fuel growth through a consistent network foundation that enables substantial cost reductions in sustaining existing applications.

The Cisco Data Center Network Architecture provides a scalable foundation that allows data centers to host a variety of legacy and emerging systems and technologies. Among these technologies are the following:

- **N-tier Applications**—Secure network zones support two, three, or n-tier application environments with techniques that optimize application availability and server and storage utilization.
- **Web Applications**—Application Acceleration and Server Optimization technologies including HTML provide improved scalability and delivery of web applications to end-users, wherever they are.
- **Blade Servers**—The Data Center Network Architecture helps reduce risks associated with blade server deployment by providing an intelligent network foundation, integrated Ethernet and Infiniband switching technology, and deployment guidance that help optimize their availability, security, and performance.
- **Clustering, High-Performance Computing and Grid**—Cisco's high-performance data, server, and storage switching solutions, whether Ethernet, Infiniband or Fibre Channel based enable the deployment of data and I/O intensive applications that make use of these distributed compute and storage architectures.
- **SOA and Web Services**—Cisco's Data Center Network Architecture facilitates the reliable, secure and rapid deployment of a SOA, by enabling dynamic deployment and scaling of secure infrastructures and by enhancing application integration with message-based services.
- **Mainframe Computing**—Cisco offers a comprehensive set of technologies supporting Systems Network Architecture (SNA), SNA-to-IP migration, FICON, GDPS and native IP mainframe services.

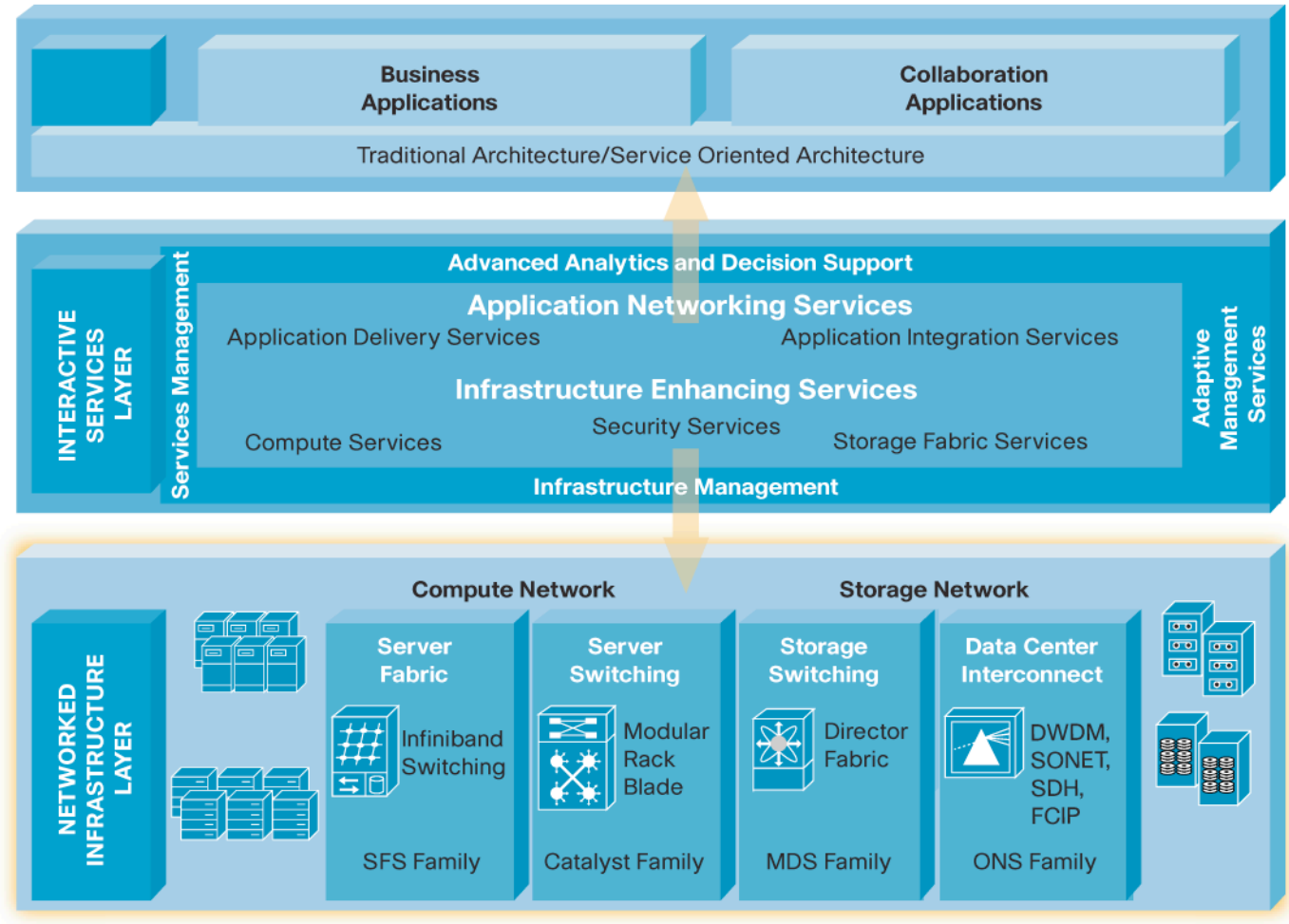
ELEMENTS OF THE CISCO DATA CENTER NETWORK ARCHITECTURE

Based on SONA, the Cisco Data Center Network Architecture (Figure 2) comprises the following layers:

- **Networked Infrastructure Layer**—Meets all the bandwidth, latency and protocol requirements for user to server, server to server and server to storage connectivity and communications.
- **Interactive Services Layer**—Provides the Infrastructure Enhancing Services which ensure the fast and secure alignment of resources with application requirements and Application Networking Services that optimize application integration and the delivery of applications to end users. These services are integrated into the Cisco networking platforms that comprise the Networked Infrastructure Layer for enhanced, scalability, manageability and transparency.

This architecture supports the deployment of business applications and collaboration applications, whether deployed with traditional application architectures or emerging service oriented architectures.

Figure 2. Cisco Data Center Network Architecture: Network Infrastructure Layer

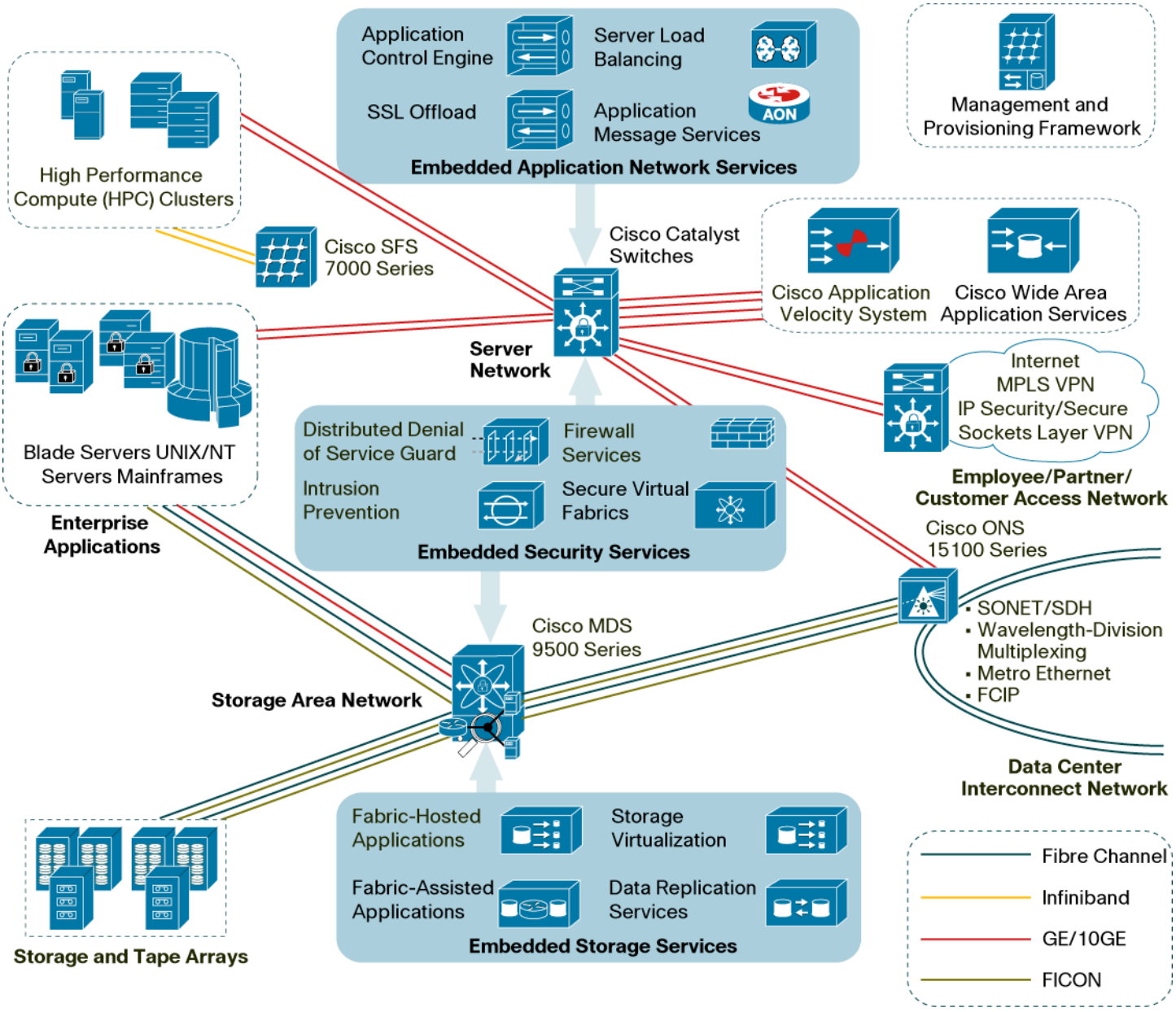


NETWORKED INFRASTRUCTURE LAYER

The foundation of the Cisco Data Center Network Architecture provides intelligent connectivity services for networked elements within the data center, such as servers and storage, as well as to external users or other data centers. The network fabric is built with highly resilient, scalable platforms that integrate intelligent services directly into the fabric. It comprises purpose-built platforms that address unique connectivity requirements including highly scalable and service-rich server farm switching; high bandwidth, ultra low latency server fabric switching; highly scalable, multiprotocol intelligent storage switching; and high bandwidth, long distance data center interconnect. Multiprotocol support ensures that all unique application requirements can be met. For example a high performance compute cluster may require Infiniband, a data intensive grid application may require 10 Gigabit Ethernet, a heterogeneous SAN may require Fibre Channel, Fiber Connection (FICON) and iSCSI, while a synchronous mirroring application may need DWDM connectivity between data centers.

Figure 3 describes how these networked infrastructure platforms could interconnect with users, compute resources, storage resources and secondary data centers to support a consolidated data center infrastructure. We will now describe each of these platforms in more detail.

Figure 3. Data Center Network Topology



Networked Infrastructure Layer: Server Farm Network

The consolidation of data center infrastructure is accompanied by the need for a highly scalable server farm network, capable of scaling and providing secure environments for each of the hosted applications. Cisco's intelligent IP network infrastructure provides secure, optimized user access to applications and high-speed reliable communications between server tiers and clustered computing resources and applications. Cisco offers data center managers an IP network infrastructure with the intelligent switching capabilities of its proven, award-winning family of Cisco Catalyst® switches. Cisco continues to enhance these platforms for data center applications with innovations such as high density Gigabit Ethernet and 10 Gigabit Ethernet technologies, high availability services, integrated security and application networking services modules. These platforms are key enablers of consolidation and virtualization, providing secure isolated environments for different application tiers and server farms, upon a single

physical switched infrastructure. These platforms meet today's rigorous demands for flexibility, availability, and performance, yet their modular design permits upgrades to support future technologies and services with minimal disruption and expense.

The ability to integrate vital intelligent services—such as firewall, intrusion protection, server load balancing, and secure socket layer (SSL) offload—directly into the network fabric requires a new approach to data center design. Furthermore the ability to virtualize these services and apply them as appropriate to the hosted application environments, make the Catalyst switches uniquely suited for large scale data center server farms. Cisco design guides offer a "services layer" that resides between the traditional aggregation and core layers of the data center network. This centralized tier manages and controls intelligent services across all application and server environments and releases data center architects from the requirements of specific computing platforms, because services can be virtualized and shared throughout the data center.

Catalyst 6500 Product Specification URL: http://www.cisco.com/en/US/products/hw/switches/ps708/index.html

Networked Infrastructure Layer: Server Fabric Network

Academic and research communities were the first to realize the potential for clustering low cost commodity servers to run computationally intensive applications. Many Enterprises are now looking to use the same cluster techniques to run commercial high performance applications to provide faster "time-to-information" at an economically viable cost point. High Performance Compute (HPC) applications enable better decisions to be made, faster and at lower cost and ultimately provide competitive advantage in the market.

Typically, HPC clusters are built from commodity servers running software that enables distributed, parallel processing of an application across multiple nodes. One characteristic of HPC is that high throughput and low latency are required to maximize cluster efficiency and performance.

A simple explanation of an HPC is where two or more computers, or compute nodes, are used to solve a single problem. Typically, most HPCs are built from commodity servers running software that enables distributed, parallel processing of an application across multiple nodes. As the applications are typically highly parallel, inter-process communications between nodes, they require high performance connections to maximize cluster efficiency and performance.

Cisco Catalyst Ethernet solutions and Infiniband Server Fabric Switches provide cost effective, high performance server interconnect technology that provides the high bandwidth and low latencies required for the most demanding HPC environments. Cisco can offer both an Infiniband solution, for applications that require high bandwidth, low latency inter-CPU communications, or Ethernet when the application can tolerate marginally higher latencies.

Using standards-based Infinband technology Cisco's SFS 3000 server fabric switches provide a programmable switching platform that consists of a switched multiterabit interconnect and an intelligent control architecture. The high-bandwidth, low-latency interconnect is extremely adaptable. Server elements can be seamlessly brought on line as needed to enable an unprecedented level of application scaling, fault recovery, rapid deployment, and resource consolidation. The pooling, consolidation and virtualization of standardized, server resources dramatically increases performance levels, reduces total cost of ownership and allows IT organizations to rapidly deploy and scale resources on demand to match business and application requirements.

SFS Family Product Specification URL: http://www.cisco.com/en/US/products/ps6418/index.html

Networked Infrastructure Layer: Storage Area Network

Storage requirements are always growing. The industry transition from direct-attached storage (DAS) and isolated Storage Area Network (SAN) islands to scalable, intelligent storage networking is underway. This trend delivers substantial cost of ownership and business resilience benefits, enabling efficient storage pooling and utilization and consistent data replication and mirroring for business continuance. Storage networking is the software and hardware that enables storage consolidation, sharing, access, replication, and management over a shared network infrastructure.

Cisco storage networking solutions help storage managers reduce TCO and improve business continuance over DAS and first-generation SAN solutions. Cisco delivers next-generation storage networking with Cisco MDS 9000 Series multilayer switches. Cisco has applied its advanced data networking experience to the storage environment, changing the landscape of storage networking. For example, Cisco has adapted VLAN and IP Security (IPSec) technologies to the storage network as Virtual SANs (VSANs) and Fibre Channel Security Protocol respectively.

The flagship storage platform, the Cisco MDS 9500 Multilayer Director, elevates the standard for director-class switches with intelligent services that enhance availability, security, and manageability. Cisco MDS 9500 Series switches facilitate large-scale SAN deployment with low TCO. Using a rich set of intelligent services on a high performance, multi-protocol switch, Cisco MDS 9500 Series platforms address the stringent security and availability requirements for consolidating multiple SAN islands onto one physical SAN infrastructure. VSAN technology provides reliable, secure SAN consolidation across a single physical network. Cisco MDS 9500 Series switches support popular storage networking protocols, including Fibre Channel, FICON, Internet Small Computer Systems Interface (iSCSI), Fibre Channel over IP (FCIP), and Gigabit Ethernet. This multiprotocol solution extends SAN coverage to all systems at appropriate price and performance levels. The MDS 9000 also takes a true “platform” approach for Storage Fabric Services via open and standards-based APIs. These services can either be fully hosted on the MDS, (e.g. virtualization or serverless backup) or network-accelerated (e.g. write or tape acceleration), or alternatively network-assisted (e.g. serverless backup, replication or point-in time copy).

MDS-9000 Family Product Specifications: http://www.cisco.com/en/US/products/hw/ps4159/ps4358/index.html

Networked Infrastructure Layer: Data Center Interconnect Network

As the trend towards data center consolidation continues, the need to reduce the risk of downtime by interconnecting production and secondary data centers over metro or wide area distances becomes ever more critical. The ability to provide high-speed, low-latency data center interconnections is key to allowing the replication and mirroring of data and geo-clustering of servers between data centers. Cisco’s flexible data center interconnection solutions include the Cisco ONS 15000 family of Multi-Service Transport Platforms (MSTP). These platforms achieve very high bandwidths and low latencies through optical technologies such as dense wave-division multiplexing (DWDM) and Synchronous Optical Network/Synchronous Digital Hierarchy (SONET/SDH) services. They transport storage protocols such as FICON, ESCON, Fibre Channel, and Fibre Channel over IP (FCIP), and data services including Gigabit and 10-Gigabit Ethernet over metro and wide area distances. These platforms enable consolidation and cost control, giving data center and network managers the ability to retire redundant, inefficient networks in favor of a single infrastructure that supports storage, data, and voice applications.

Cisco ONS 15454 MSTP uses advanced Reconfigurable Optical Add/Drop Multiplexer (ROADM) technology to make it easy for the network operator to provision wavelength services anytime anywhere because they can remotely add or drop capacity at any node without impacting existing traffic. This allows dynamic wavelength delivery to support changing data center bandwidth requirements, such as periodic backups or fall-back recovery requirements. The GUI-based MetroPlanner tools provide help in designing a DWDM network based on topology, fiber infrastructure, and supported traffic. Automatic power control is built into the Cisco ONS 15454 MSTP to manage amplifier gain during network installation, correction for aging fiber, and restart after a fiber cut.

Cisco also offers several DWDM platforms for metro networks, such as the Cisco ONS 15216, ONS 15530, and ONS 15540. In addition to transparently supporting various services, benefits of these systems include increased capacity (more services, such as Gigabit Ethernet and Fibre Channel/FICON on a fiber pair), high-density service aggregation (many services on a single wavelength), scalability from 2.5- to 10- Gbps wavelengths, and service mixing (different services on the same wavelength).

Cisco's Data Center Interconnect Solutions are qualified for interoperability with the leading storage vendors, to ensure risk free reliable deployment and operation.

For more information on CWDM, DWDM, SONET/SDH and other ONS platforms please visit our web site:

ONS 15000 Family Product Specifications URL:

http://www.cisco.com/en/US/products/hw/optical/index.html

Data Center Interconnect Solutions:

http://www.cisco.com/en/US/products/hw/optical/ps2006/products_white_paper0900aecd803e884f.shtml

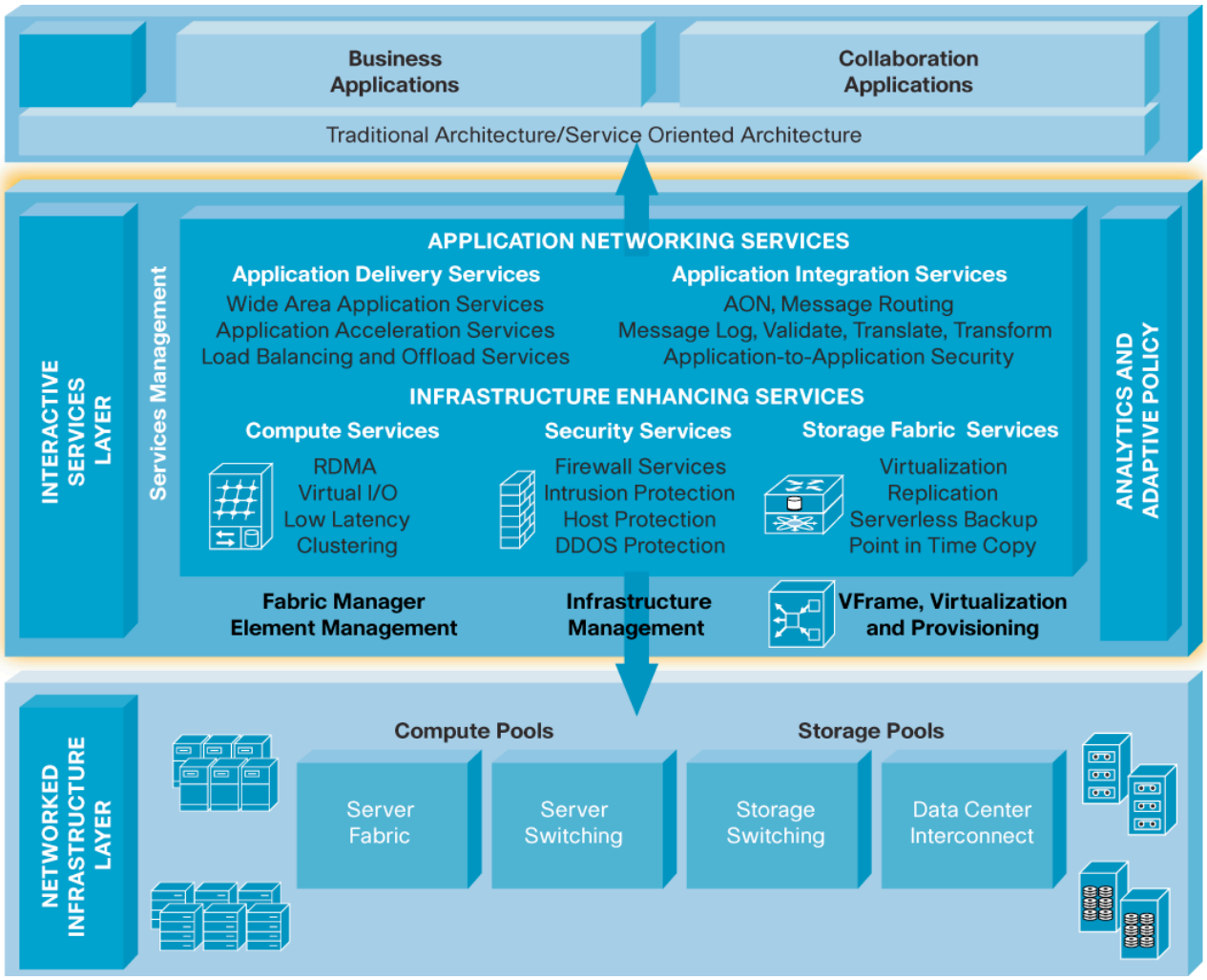
INTERACTIVE SERVICES LAYER

Data center architects can deploy, manage and protect applications, information and supporting server and storage infrastructure quickly, securely, and reliably with a network infrastructure that displays system-level intelligence, such as storage virtualization, policy-based provisioning, adaptive threat defense, and enhanced application optimization. These services facilitate the implementation of a Services Oriented Infrastructure by enabling the dynamic creation of secure application environments, and the delivery of those applications to the end user. The Cisco Data Center Network Architecture exhibits network system intelligence through a combination of interactive services integrated into the foundation infrastructure platforms, together with complementary services offered on appliances, storage systems, and server hosts. This Interactive Services Layer (Figure 4) comprises Infrastructure Enhancing Services and Application Networking Services, each of which we will now describe in more detail.

The **Infrastructure Enhancing Services** improve the reliability and security of the hosted infrastructure and applications. These services also allow centralization and standardization of heterogeneous services that were previously only available as distributed services on end systems like servers and storage. These centralized network based services allow for unified administration, improved performance and more freedom of choice regards which end systems to deploy. Examples of Infrastructure Enhancing Services include Compute Services like Remote Direct Memory Access (RDMA), and low-latency clustering. It also includes Storage Fabric Services such as virtualization, replication and virtual fabrics, and Security Services in the form of firewall, intrusion protection and Distributed Denial of Service (DDOS) protection services.

As infrastructure is consolidated to centralized locations, the delivery of applications to remote users, wherever they are becomes even more critical. In addition the trend towards SOA and web services, makes the network central to the way that applications are developed and integrated to support business processes. **Application Networking Services** enhance the delivery of applications to the end user as well as communication between application tiers, different applications and services. Application Delivery Services allow users, whether located at remote branches, home offices or on the road, an enhanced end-user experience. These services include Wide-Area Application Services, Application Acceleration Services, and Load Balancing and Offload Services.

Figure 4. Interactive Services Layer: Compute, Security, Storage Fabric, Application Delivery and Application Oriented Networking Integration Services.



Interactive Services Layer: Infrastructure Enhancing Services

The Cisco Data Center Network Architecture enables data center managers to embed high-performance centralized services formerly served on disparate storage and server devices.

Storage Fabric Services: In collaboration with industry partners, Cisco enhances the efficiency, management and availability of storage infrastructure with innovative technologies that enable scalable, heterogeneous storage virtualization, business continuance and SAN extension solutions. In Cisco MDS 9000 Series switches, the Storage Services Module (SSM) delivers a high performance hardware-based platform that improves the scalability, availability, security, and manageability of virtualization, data replication, backup, and business continuance solutions. This approach provides consistent services across different storage environments, improved uptime, and lower TCO.

The SSM offers open and standards-based API's for partners and ISVs to take advantage of. For example the Fabric Application Interface Standard (FAIS) API provides a standards-based interface to 3rd party virtualization engines, such as EMC's Invista, to pass virtualization control data to the MDS-9000. The MDS-9000 loads this data onto customized ASICs to allow high performance virtualization of heterogeneous storage. This results in higher storage utilization, creation of tiered storage services, dynamic storage provisioning and eliminates application downtime for storage maintenance. Another example of key storage fabric services includes write acceleration for extending the distance and reducing the application impact of data replication. Network Assisted Serverless Backup (NASB) eliminates backup bottlenecks and tape acceleration improves the performance of remote backups and recovery. The MDS-9000 family also supports an open API (SANTap) for appliance vendors that provide replication, snapshot and continuous data protection services. The API allows 3rd parties to provide services without being in the data path, and thereby eliminating the risk of impacting the performance or availability of the production storage environment.

Storage Fabric Services URL: http://www.cisco.com/en/US/netsol/ns515/networking_solutions_package.html

Security Services: Managers tasked with securing the disparate systems assembled quickly during the economic boom of the last decade must contend with vulnerabilities that require individual attention. They must resolve inconsistent policy enforcement and severe burdens on security staff. Also they must end their reliance on physical application isolation or perimeter defense for security. These methods are inadequate for defending resources and applications from sophisticated and dangerous attacks. Consistent protection of consolidated data centers is challenging, because attacks can spread unchecked among all systems on a single infrastructure. The network must provide in-depth, integrated security that protects servers, applications, and data within secure zones.

The Cisco Data Center Network Architecture offers security strategies, technologies, and products designed to prevent or contain attacks from both within the organization and external to the organization. These strategies are based on the principle of defense in depth, which delivers multilayer security throughout IP, storage, and interconnection networks. Cisco enables consistent security policy enforcement with comprehensive security solutions. Integrated security service modules for Cisco Catalyst 6500 Series platforms provide virtualized, hardware-based firewall capabilities between VLANs, intrusion detection, Distributed Denial of Service (DDOS) defense, and SSL and IPSec VPN termination. Rounding out the security portfolio is an extensive list of Cisco IOS Software security capabilities, security management tools and end-point host protection solutions that can provide day-zero protection.

On the storage network, VSANs provide secure environments for various applications and standards-based host authentication to ensure data confidentiality. The Cisco Self-Defending Network vision takes integrated in-depth security to the next level with systems-based security solutions that advance infrastructure security policy enforcement, respond faster to threats, and reduce manual interaction through automation.

Security Services URL: http://www.cisco.com/en/US/netsol/ns340/ns394/ns171/networking_solutions_packages_list.html

Compute Services: Consolidated data center environments are more dense in their computing capacity and somewhat more homogeneous in their server platforms and supported OS. Compute services are focused on increasing the effective manageability, aggregation, virtualization and automated on-demand provisioning of computing resources. This implies that the services in dense data center environments must be able to provide a network fabric that supports the dense infrastructure; the mechanisms to control the compute resource pool made out of CPUs, memory, and I/O; and the tools to dynamically allocate resources based on the changing application environment needs. The improvement of average server utilization requires a loose coupling between applications and servers creating an automatic and dynamic relationship. This loose coupling is possible through virtualization capabilities where applications map to available compute resources in real time.

Compute Services also include those services that off-load processing from the servers to ensure that server processing power to be used to support the transactional and business logic they are uniquely well suited to support. This includes such processor-intensive services such as SSL and TCP termination. Additional compute services include the intelligence provided by the network fabric to understand and support the protocols that best use the available compute resources, and that optimize the communication exchange between them. Compute services include a low latency fabric (Ethernet or Infiniband), high throughput capabilities, the linkage to Inter Process Communication (IPC) across multiple hosts such as RDMA, and the tools to manage the resource pools in a demand driven environment such as VFrame.

Application Delivery Services: As applications are consolidated into central data centers, it is critical to provide services that can optimize delivery of those applications to the end users, whether they are employees in remote offices, customers across the Internet, or partners across the world. Cisco's portfolio of application delivery services address the broadest range of application types, including web based applications, file and print services, IP communications, messaging and rich media services.

Cisco's Wide Area Application Services (WAAS) enables branch employees seamless access over the WAN to centrally hosted applications, storage and rich media. These services allow enterprises to consolidate their distributed servers and storage into centrally managed data centers, while offering LAN-like access to their remote users. The WAAS technology includes caching, compression and protocol optimizations that overcome bandwidth and latency limitations associated with file services and client-server protocols.

Application Acceleration Services optimize delivery of web-based application (HTML and XML) to remote users while minimizing bandwidth usage and maximizing infrastructure capacity in the data center. Based on Cisco's AVS product line, this technology uses innovative techniques that provide bandwidth efficiencies, decreased latency, and server offload across the network. In real-world deployments, customer's dramatically improved end-user response times by up to five times, reduced application bandwidth usage by up to 90 percent, and reduced server load by up to 90 percent. Advanced multicast support and quality-of-service (QoS) mechanisms protect application performance as traffic leaves the bandwidth-rich data center for lower-speed connections to users.

Application Delivery Services URL: http://www.cisco.com/en/US/products/hw/contnetw/index.html

Cisco Application-Oriented Networking (AON) technology is the foundation for a new class of network-embedded products and solutions that help the convergence between intelligent networks and application infrastructure capabilities across both traditional architectures and service-oriented architectures. Cisco AON technology provides application message-level intelligence in the network to better meet the underlying needs for application collaboration, application-to-application security, and application message/business event visibility to help more effectively deploy and interconnect applications, and to help the enterprise see and respond more effectively to changing business conditions in real-time.

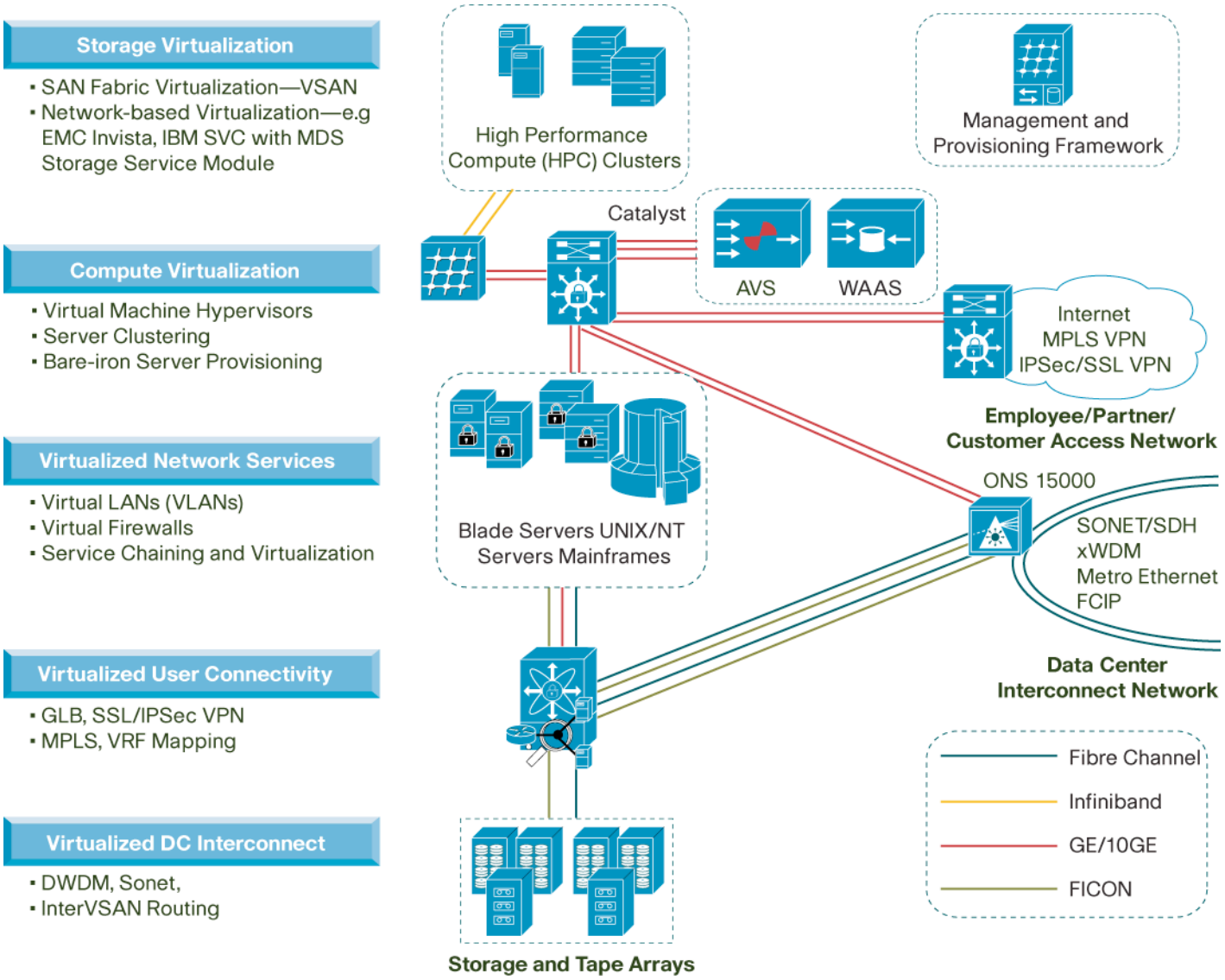
The Cisco Data Center Network Architecture provides advanced common management interfaces, capabilities, and tools to substantially enhance operational efficiency of data center administration, reducing complexity and learning cycles, leading to improved service levels and faster problem resolution. Role-Based Access Control allows administrators to allocate management control of designated resources to specialized personnel.

The Cisco Data Center Network Architecture has five manageability areas:

- **Simple Network Management Protocol (SNMP) Version 3**—Supports common MIB format across IP switched and routed, storage, and optical networks, assisting configuration, inventory, and change management.
- **Embedded Management Agents Simplify Manageability**—Enables adaptive policy-based management, rapid response to issues before they escalate into problems, and simplified service implementation. For example, the CiscoView Device Manager agent for Cisco Catalyst 6500 Series platforms and Fabric Manager agent for the MDS-9000 family facilitate end-to-end, policy-based configuration.
- **Similar Cisco IOS Software and SAN OS Command-Line Interface**—Provide consistent communication between managers and devices
- **Standard Common Information Model and Extensible Markup Language (XML) Management APIs**—Simplify implementation of third-party systems management
- **Common Advanced Diagnostics Capabilities**—Ease real-time monitoring, historical statistics collection, and reporting

ACHIEVING DATA CENTER VIRTUALIZATION

Figure 5. Network Virtualization and Network-Enabled Virtualization of Computing and Storage Resources



The step beyond consolidation is data center virtualization, which allows data center managers to create an abstraction layer between applications and the underlying sever, storage and network infrastructure. Virtualization is the creation of one logical entity from multiple physical entities or, alternatively, the creation of many logical entities from one physical entity. An entity can be computing, storage, network, or application resources. Virtualization results in a number of compelling benefits including better utilization, faster provisioning and reduced impact of planned maintenance on application availability. Another key benefit of virtualization is the dynamical creation of multiple, separate IT infrastructures, secured and isolated from each other, yet running on a single physical infrastructure. These separate infrastructures from user-to-spindle can support separate workgroups, Lines of Business or companies, each with access rights to specific applications and services.

Virtualization is well adopted in the networking sphere. Typical network virtualization technologies include VLANs, Frame Relay/Asynchronous Transfer Mode, Permanent Virtual Circuits, and VPNs.

Now Cisco enables data center virtualization and provisioning across storage, compute, network and interactive services environments.

Working with partners, Cisco deploys advanced storage virtualization technologies integrated onto the Storage Services Module for Cisco MDS 9000 Series platforms. This solution provides central point volume management for provisioning, especially in heterogeneous storage environments. It reduces the cost of storage for backups and data warehousing with improved utilization.

Cisco's Server Fabric Network platforms enable enhanced server virtualization through the use of virtualization and boot services and virtualization software. The software allows distinct server entities to be designated as generic stateless servers over the server switch fabric. By separating the server entity from the physical infrastructure, Cisco makes it possible to create customized virtual servers on-demand out of industry-standard components.

- **Virtualization and Boot Services**—Make servers truly "stateless" by loading their unique aspects over the network, including any combination of application, OS, storage, security, and I/O resources.
- **Server Virtualization Software Suite**—Embeds policy and provisioning intelligence into the server switch hardware. This allows the Cisco server fabric switch to be programmed with the intelligence to determine when and how to create virtual servers out of shared resources.

ACHIEVING HIGH AVAILABILITY AND BUSINESS CONTINUANCE

Business continuance is critical to data center consolidation since businesses faced with growing dependence on employee, customer and partner facing application as well as increased regulations need to improve response and recovery from disruptions. Because disruptions can severely disrupt a business, enterprises frequently deploy secondary data centers that take over should the primary data center fail. This has become an even higher priority, given the trend toward data center consolidation and emerging regulatory requirements. Although it is desirable to maintain uninterruptible access to all data center applications, the economics of business continuance require managers to prioritize applications according to business criticality. Therefore, data centers need a range of business continuance systems from simple tape backup and remote replication to synchronous mirroring and mirrored distributed data centers.

Enterprises require a resilient, integrated business continuance network infrastructure to protect data, rapidly recover applications, and ensure continuous user access in the event of a disruption. The Cisco Data Center Network Architecture supports a comprehensive business continuance strategy with multiple user access technologies and enhanced communications between data center and recovery sites. Cisco business continuance networking solutions use a range of technologies to meet application recovery requirements (Figure 6). These technologies revolve around ensuring data resilience, application resilience and user access resilience.

Data Resilience

The Cisco Data Center Network Architecture offers a rich set of technologies and features to enhance the protection, replication and backup of data:

- **High-Capacity, Low-Latency Data Center, MAN, and WAN Data Center Interconnections**—Based on Cisco storage, optical, and wide-area networking solutions, these high-bandwidth, low-latency solutions enable zero-data-loss data mirroring to protect user sessions, prevent transaction loss, and support automatic failovers between mirrored sites.
- **SAN Extension** technologies, such as Fibre Channel over IP (FCIP), compression, encryption and Inter-VSAN Routing on Cisco's MDS 9000 platforms enhance the distance, security, bandwidth utilization of replication and backup to remote sites. In addition, technologies such as write acceleration, tape acceleration and server-less backup reduce latencies, extend distances and reduce application impact of storage replication applications.
- **Support for 3rd party Business Continuance Applications**—Cisco's SANTap API's allow the MDS to provide a resilient platform to 3rd party applications such as replication point in time copy and continuous data protection.

Application Resilience

Application resilience can be enhanced by the network in a number of ways:

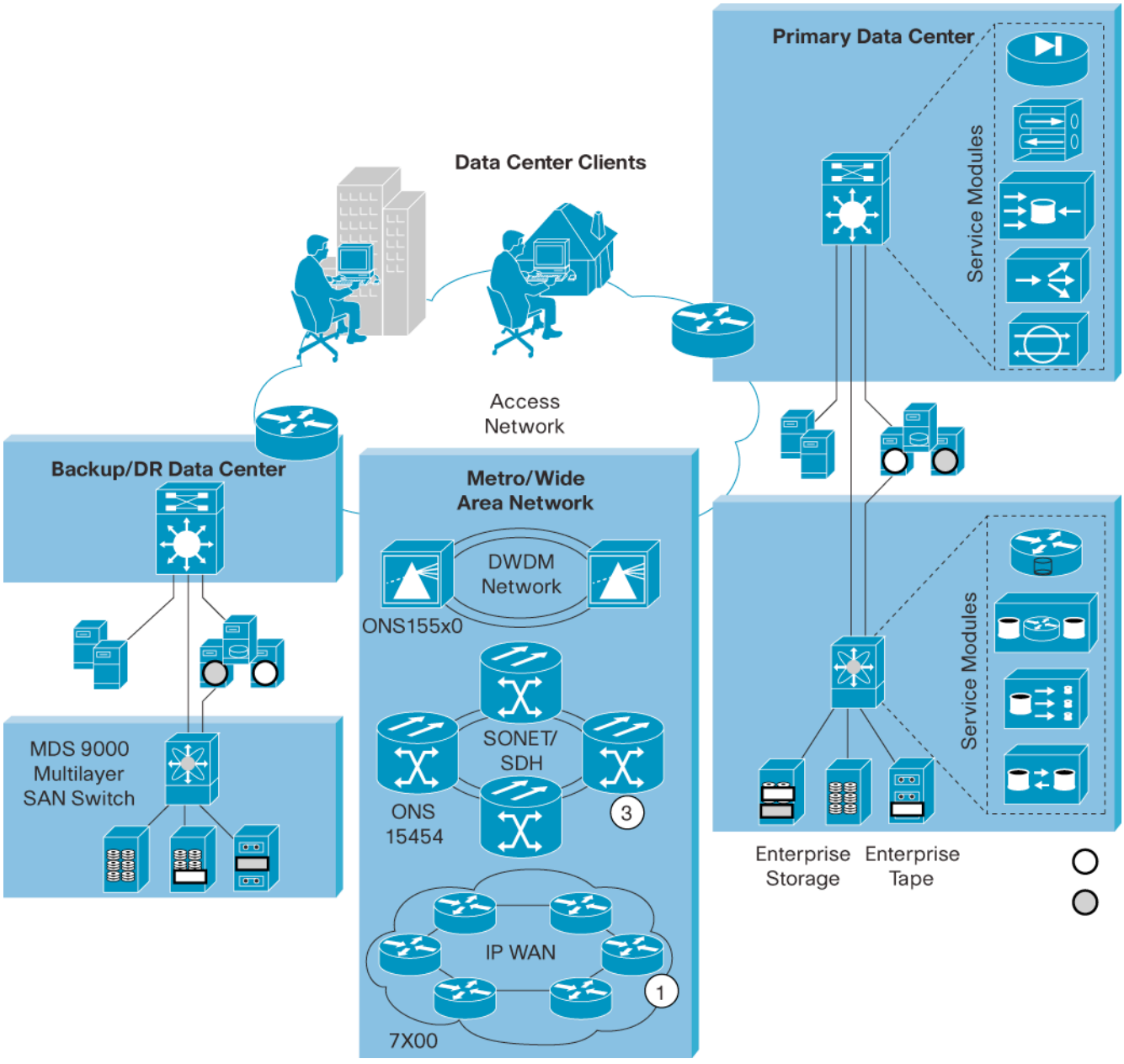
- **Remove Single Point of Server Failure**—Support for High Availability clusters, load balancing across web and application servers and high performance clusters enables IT organizations to protect against server failures.
- **Extending Application Environments between Data Centers**—To protect against major data center disruptions, companies are looking to extend their clusters between data centers. Examples of this include IBM mainframe Geographically Dispersed Parallel Sysplex (GDPS) and Microsoft's, GeoCluster for SQL Server. To achieve this type of redundancy requires a high speed, low latency metro network.

User Access Resilience

Traditionally IT has concerned itself with Recovery Point Objective (RPO) i.e. How much data can I afford to lose, and Recovery Time Objective (RTO), i.e. How much application downtime can I afford? However just important is Recovery Access Objective (RAO), how long can the business afford for users to go without access to applications following a disruption. The Cisco architecture addresses this requirement in a number of ways.

- **Virtual Private Networks** allow customers from branch offices and telecommuters to reconnect to applications as soon as they are up and running.
- **Global Site Selector**—Allows users to manually or automatically connect to the most available web application available at any given time. In the case of a disruption in any one application environment, users continue to have access to the alternate site.

Figure 6. Cisco Business Continuance Networking



OPERATIONAL EFFICIENCY

Cisco and its partners take advantage of the extensive manageability capabilities of network devices and advanced network management tool sets to achieve operational efficiency for the Cisco Data Center Network Architecture.

Network Management Tools: Network and Data Center operators and architects can use a broad array of specialized tools provided by Cisco and partners to gather information offered by the network and apply controls that provision, configure, monitor, and tune the infrastructure. Cisco network management solutions allow administrators to simplify operations and increase productivity, thereby reducing TCO throughout the data center life cycle.

Among the network management solutions that Cisco offers is CiscoWorks, a comprehensive suite of tools with Web-based GUIs. Network administrators can trust the workflow automation capabilities of the many CiscoWorks tools, which use a Web interface to create scripts and perform complex tasks in a normalized automated process. CiscoWorks includes powerful applications for centralized, automated provisioning, change management, monitoring, and troubleshooting of data center networks. It delivers full configuration, performance, monitoring, and troubleshooting capabilities within an easy-to-use, integrated framework. It enables role-based services tailored to the operational domains of the data center, such as security, storage, network infrastructure, and capacity planning. Its standards-based interfaces allow integration with third-party applications.

Cisco Fabric Manager is a responsive, easy-to-use, Web-based application that simplifies the management of Cisco MDS 9000 Family switches in storage area networks (SANs) through an integrated approach to switch and fabric administration. Cisco Fabric Manager offers storage administrators fabric-wide management capabilities, including discovery, multiple switch configuration, continuous network monitoring, and troubleshooting. This powerful approach greatly reduces switch setup times, increases overall fabric reliability, and provides robust diagnostics for resolving network problems and configuration inconsistencies.

VFrame is a datacenter provisioning and orchestration product that enables the rapid commission and decommission of shared pools of server and I/O resources on demand. Cisco® VFrame system management software creates virtual “compute services” by programming server switches to map diskless servers to shared pools of I/O and storage resources. VFrame dramatically reduces total cost of ownership by enabling administrators to provision compute services in seconds, automate tasks based on business policies; and simplify network and server architectures. VFrame also reduces data center downtime through automated server failover, centralized I/O management, and diskless servers.

DATA CENTER PARTNERSHIPS

The Cisco Data Center Network Architecture provides a flexible intelligent network foundation for leading data center vendors to offer customers complete compute, storage, and application environments. These partners include market leaders such as EMC, Hewlett Packard, HDS, IBM and Microsoft. Cisco collaborates with industry leaders in a variety of disciplines to facilitate smooth, integrated delivery of data center infrastructures that enterprises can tailor to their unique requirements. These partnerships give data center managers the resources they need to design, deploy, and maintain agile data centers that effectively support their business goals.

ACCELERATE SUCCESS WITH CISCO EXPERTISE, SERVICE, AND SUPPORT

Cisco Technical Support Services and Advanced Services provide 24 hour access to data center network technology engineering expertise, real-world tested processes and procedures, innovative support tools, and a network of specialized partners ready to help data center managers meet demanding requirements.

Cisco services help data center and network managers optimize network investments by providing expert planning assistance specifically for data center environments. This expertise helps maximize network uptime and performance by designing in network resiliency, availability, and security, and by measuring and optimizing network capacity and performance levels on an ongoing basis. Cisco services provide data center network planning, design, and implementation best practices along with skilled, experienced engineers to deploy robust data center networks that enable customers to efficiently deploy applications and improve business performance.

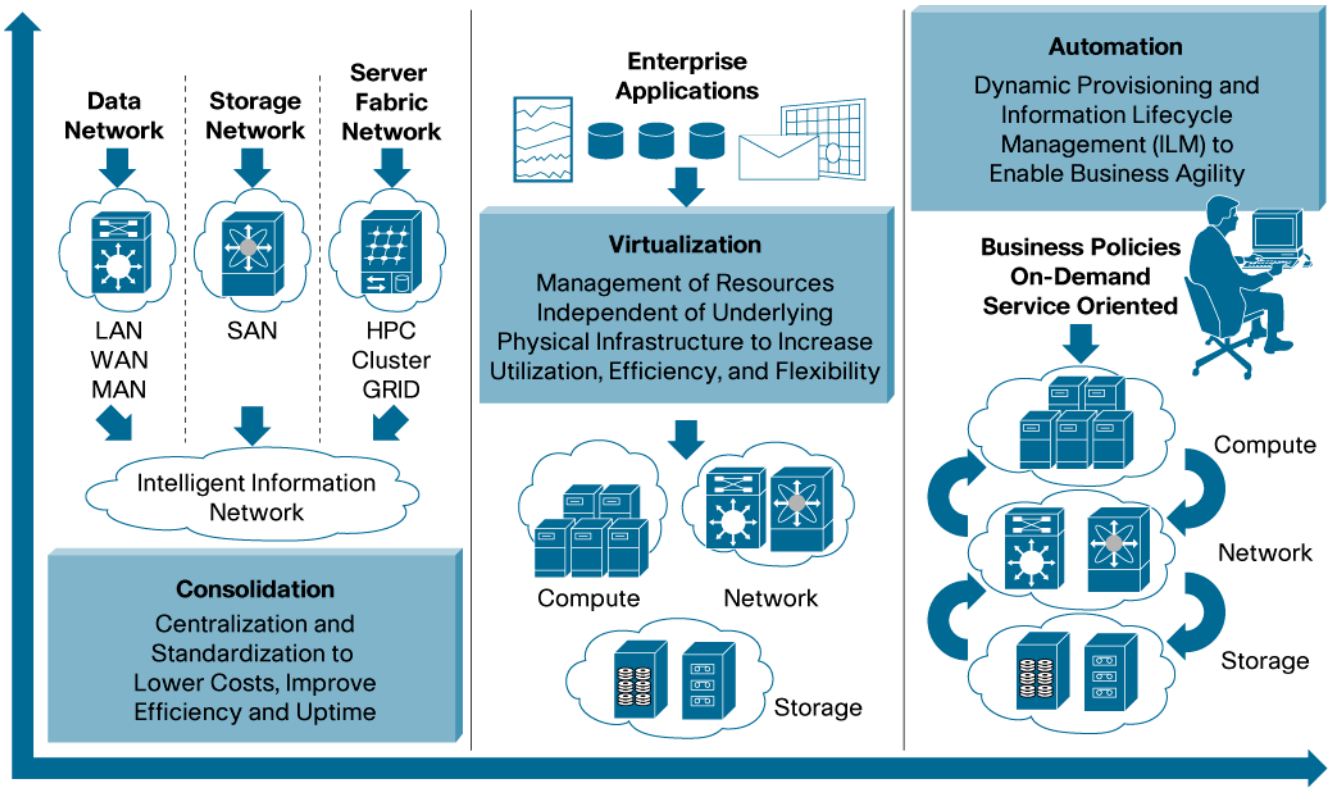
ONGOING INNOVATION IN THE ENTERPRISE DATA CENTER

The Cisco Data Center Network Architecture offers strategies that help enable businesses respond to industry trends and prepare for the future. Cisco helps its customers take a strategic approach to data center networking to realize the promises of protection, efficiencies, and business agility through technology. The Cisco architecture addresses both near- and medium-term demands while laying a solid foundation for the future. Enterprises that invest in a Cisco data center network today also prepare for the future, because Cisco takes a systems-approach to evolving the data center network technologies in unison, to meet new customer needs and to take advantage of ongoing industry breakthroughs.

Cisco understands that the next-generation data center is best achieved through a phased approach, and is developing data center networking technologies and solutions that allow customers to evolve their data center infrastructures through consolidation, virtualization, and automation phases.

- **Consolidation**—Integration of network, server, application, and storage services into a shared infrastructure that enhances scalability and manageability while reducing cost and complexity.
- **Virtualization**—Network-enabled virtualization of computing and storage resources, as well as virtual network services increase utilization and adaptability while reducing overall costs.
- **Automation**—The dynamic monitoring, provisioning and orchestration of data center infrastructure resources resulting from changing loads, disruptions or attacks increases overall IT agility while minimizing operational requirements.

Figure 7. Cisco Data Center Network Architecture



WHY CISCO?

The Cisco Data Center Network Architecture enables data center managers to transform their data centers into strategic assets that help them increase productivity and efficiency, reduce costs, and enhance business resiliency and agility. The architecture delivers the most integrated, end-to-end data center networking solution, empowering enterprises to gain the greatest level of control when aligning data center resources with business needs through the combination of networked infrastructure and interactive services inherent in Cisco Data Center Solutions.

By adopting the Cisco Data Center Network Architecture framework, IT managers can consolidate management, training, sparing, and support costs to reduce operational costs, speeding both problem resolution and application deployment. Backed by expert professional services, world-class service and support, reference designs, and valuable partner relationships, Cisco Data Center Network Architecture offers a complete networking solution for real-world data center demands.

FOR MORE INFORMATION

For more information about Cisco Data Center Network Architecture and Data Center solutions, go to: http://www.cisco.com/go/datacenter

Corporate Headquarters
Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134-1706
USA
www.cisco.com
Tel: 408 526-4000
800 553-NETS (6387)
Fax: 408 526-4100

European Headquarters
Cisco Systems International BV
Haarlerbergpark
Haarlerbergweg 13-19
1101 CH Amsterdam
The Netherlands
www-europe.cisco.com
Tel: 31 0 20 357 1000
Fax: 31 0 20 357 1100

Americas Headquarters
Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134-1706
USA
www.cisco.com
Tel: 408 526-7660
Fax: 408 527-0883

Asia Pacific Headquarters
Cisco Systems, Inc.
168 Robinson Road
#28-01 Capital Tower
Singapore 068912
www.cisco.com
Tel: +65 6317 7777
Fax: +65 6317 7799

Cisco Systems has more than 200 offices in the following countries and regions. Addresses, phone numbers, and fax numbers are listed on **the Cisco Website at www.cisco.com/go/offices.**

Argentina • Australia • Austria • Belgium • Brazil • Bulgaria • Canada • Chile • China PRC • Colombia • Costa Rica • Croatia • Cyprus
Czech Republic • Denmark • Dubai, UAE • Finland • France • Germany • Greece • Hong Kong SAR • Hungary • India • Indonesia • Ireland • Israel
Italy • Japan • Korea • Luxembourg • Malaysia • Mexico • The Netherlands • New Zealand • Norway • Peru • Philippines • Poland • Portugal
Puerto Rico • Romania • Russia • Saudi Arabia • Scotland • Singapore • Slovakia • Slovenia • South Africa • Spain • Sweden • Switzerland • Taiwan
Thailand • Turkey • Ukraine • United Kingdom • United States • Venezuela • Vietnam • Zimbabwe

Printed in the USA C07-331336-00 02/06