Using Infrastructure Service Orchestration to Enable a Service-Oriented Architecture

Overview

A few years ago the conventional wisdom was that the way to increase a company's earnings was to reduce cost. Today 78 percent of companies plan to increase earnings through growth. To enable this growth, companies require more agile business processes. However, 43 percent of IT departments are regularly unable to make requested changes to systems and as a result are far more likely to be regarded as inhibitors of business agility than as enablers. Therefore, IT organizations are under continuous pressure to simultaneously decrease costs and improve responsiveness. IT can adopt two complementary strategies to help achieve these goals:

- One strategy that has gained significant impetus over the last few years is to break monolithic applications into small, reusable components. The latest version of this trend, building on the growing popularity of Extensible Markup Language (XML), is known as service-oriented architecture (SOA). SOA lets companies deploy applications more quickly and at reduced cost by promoting reuse and facilitating integration.
- The second strategy is to provide infrastructure resources by means of services. This strategy has multiple names, including utility computing, on-demand computing, real-time infrastructure, and service-oriented infrastructure (SOI).

This document uses the term service-oriented infrastructure to describe the provisioning and management of infrastructure as a service from a pool of shared resources, which are aggregated, secured, and presented as services across a network fabric. Consistent with the objectives for SOA, SOI facilitates the reuse and dynamic allocation of necessary infrastructure resources.

SOI is a response to the poor efficiency, utilization, and provisioning models of modern n-tier infrastructure. The result of the current fractured data center infrastructure model is that the typical Fortune 500 company spends more than half its IT budget on data centers, and costs of data center operations are expected to increase 70 percent over the next 10 years[1]. Add to this the pressing need for greater energy efficiency and the goal of most organizations to be socially responsible in their energy use.

The SOI approach allows IT organizations to reduce operations costs, increase resource utilization and energy efficiency, boost resilience, and improve agility in provisioning and scaling data center resources. An SOI achieves these objectives by delivering infrastructure as a service from a pool of shared or virtualized resources. Shared resources are aggregated, secured, and presented as services across a network fabric.

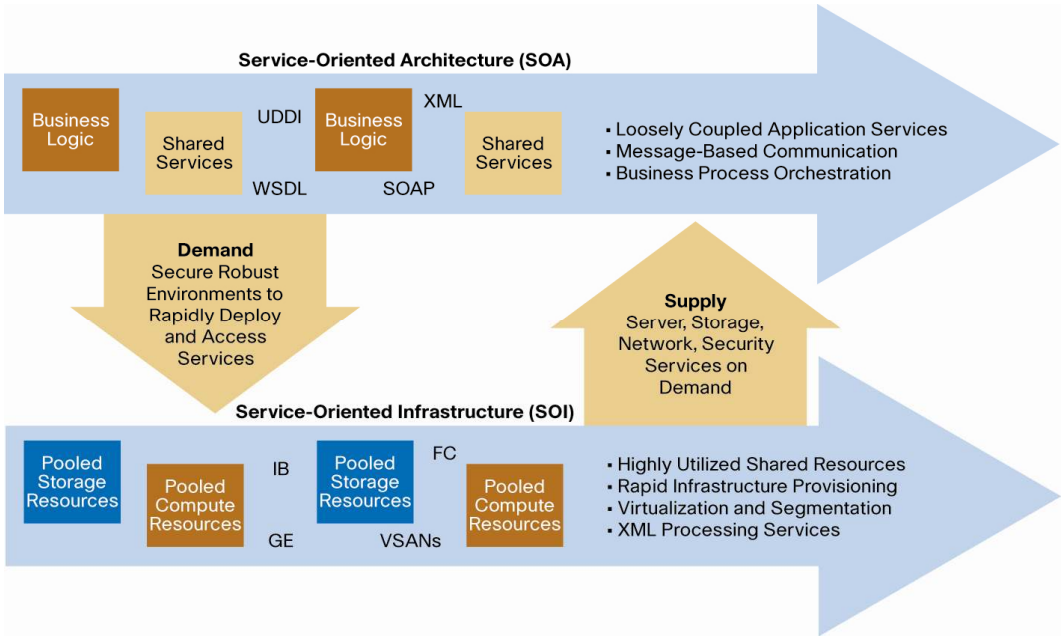
Both SOA and SOI are based on obtaining efficiency and agility by implementing IT systems as layers of services. Although SOA and SOI are independent strategies and based on different technologies (XML Web services compared to networked computing technologies and protocols), delivering a SOA on an SOI platform offers clear advantages, summarized in Figure 1. These advantages include faster deployment, dynamic scalability, improved security and control, and

[1] Drew Robb, "The Data Center of the Future," CIO Update, Dec. 16, 2003.

easier cross-enterprise integration. An SOI can be perceived as optimally meeting the infrastructure demands of a SOA.

This document briefly describes the approaches and benefits of each of these trends and how the SOI facilitates the deployment of a SOA. The document then discusses the importance of service orchestration in making SOI a reality and how Cisco® VFrame Data Center (DC) uses the unique ubiquity of the network to achieve this.

Figure 1. SOA and SOI: Complementary Strategies



Service-Oriented Architecture: A New Way Of Building Applications

Although the objectives of applying reuse and modularity to application design are not new, the widespread availability of Web services technologies built on top of XML standards has given a new momentum to SOA. Some of the main objectives of SOA include the following:

- Improve the overall alignment of IT with business processes: Web services can be designed to directly implement individual business activities. The expected result is that as business processes change, these services can quickly be rearranged to reflect new workflows.
- Control the cost of creating new business applications: Preventing duplication of applications or application services is a major motivation for a SOA. A new application can be created largely through reconfiguration of existing SOA modules. Reusable modules also greatly reduce the development time and maintenance costs, while simultaneously increasing the consistency of the data and quality of the application.
- Improve the ability to integrate applications (for example, custom applications, packaged applications, and third-party application services): SOA interfaces facilitate standards-based application integration without the need for special adapters or information bus technology.
- Comply with regulations that require confidentiality, concurrency, and integrity of information: A SOA can facilitate the establishment of a “single source of truth” that can be protected, validated, and relied upon better than multiple disparate data sources.

- Preserve the investment in existing applications: Existing code and platform-dependent implementations can be preserved as SOA application components or business services modules.

Characteristics of a SOA

Functions are Defined as Reusable Services
A function can be a complex business transaction such as "create a mortgage application" or "schedule delivery." A function can also be a simple capability such as "check credit rating" or "verify employment."

Services Protocols are Platform Independent
Although services are in most cases platform dependent, the messaging and transport protocols that services use to communicate are platform independent.

Services are Dynamically Located and Invoked
It is irrelevant whether the services are local or remote to the consumer of the service. It also does not matter what interconnect scheme or protocol is used to effect the invocation or what infrastructure components are required to make the connection.

The Primary Web Services Components

XML
Extensive Markup Language is the data format for passing messages between applications.

WSDL
Web Services Description Language is the XML-based language that is used to describe a Web service.

SOAP
Simple Object Access Protocol is the protocol by which data is transported between the device requesting the service and the provider of that service.

UDDI
The Universal Description and Discovery of Information is a registry where available services are published.

Multiple definitions of SOA exist. This document uses the following definition (see http://cs.jaxdug.com/blogs/davidstrommer/archive/2005/06/13/706.aspx):

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SOA is about loosely coupled systems,
message-based communication, and business
process orchestration. As an abstract
architectural model, it acts as an
interface between the business and the
technology layers. Web services are the
preferred implementation technology for
SOA.
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With SOA, an application is divided into numerous distinct components or modules for user interactions, business processes, and business services.

A primary aspect of a SOA is the definition of business services. Business services must perform complete units of work that are meaningful from the perspective of the business. The completeness and relevance of the business service are what make it reusable and therefore a potential component of multiple future SOA applications. As a complete entity, the business service must integrate validation logic, business transaction logic, and data access capabilities.

Service-Oriented Infrastructure: A New Way Of Building Infrastructure

At the center of IT's ability to help the organization optimize, compete, and grow are the applications that support the organization's business processes. However, there is a significant, widening, and broadly recognized gap between the capability of the infrastructure and the increasing business demands being placed on it.

Some of the primary demands placed on infrastructure include the requirement to support increased agility, reduce cost, comply with industry and governmental regulations, deliver committed application service levels, and implement more effective information management. However, meeting these demands using traditional infrastructure silos is difficult, if not impossible.

Challenges of Standalone Infrastructures

In most cases, new infrastructure has been deployed for each new application. This infrastructure is often funded and selected by application groups that are embedded in the company's business units rather than by a central IT organization. However, the central IT organization often finds itself maintaining and operating all these complex, disparate infrastructures as well as responding to expectations that IT will meet service levels and control costs.

Deploying infrastructure on an application-by-application basis leads to a fractured infrastructure, which leads to higher cost of operation and slow response to change. Other problems include the following:

- Heterogeneous systems: A wide range of computing platforms, operating systems, storage devices, and network infrastructure, results in high operational overhead and inconsistent processes.
- Isolated silos of resources: Computing, network, and storage resources are available only to the application that they were deployed to support.
- Underutilization: Server utilization varies by platform, but is typically low (for Windows, 8 to 15 percent; UNIX, 28 to 45 percent; and mainframes, 65 to 75 percent).[2] Large enterprises typically employ (and underutilize) thousands of small servers. Overall data center utilization is about 25 percent.[3]

Evolving to an SOI

A new infrastructure model is required that will meet these new business expectations. Many IT organizations have come to the realization that to meet these expectations they must deploy a shared, virtualized SOI model. Wherever possible, they are basing this model on a standard operating environment in which infrastructure resources are dynamically provisioned. This model will yield immediate measurable benefits, freeing funding for new IT initiatives, and at the same time provide the infrastructure foundation to support a SOA.

Just as a SOA has two layers (interaction and business), two layers can be used to describe the SOI model: hardware resources and infrastructure services.

- Hardware resources: Network, storage, and computing
- Infrastructure services: Security, storage services, computing services, virtualization, directory, provisioning, capacity planning, fault monitoring, metering, and billing

To increase use and efficiency, the hardware resources need to be pooled and made dynamically available. Infrastructure services help with the provisioning, monitoring, scaling, and secure operation of hardware resources. These services are implemented in a federated model that allows policy to be managed centrally but enforced in a decentralized fashion throughout the network.

[2] Brad Day, "Drivers for Server Consolidation," Forrester Research, June 30, 2005.
[3] Drew Robb, "The Data Center of the Future," CIO Update, December 16, 2003.

Table 1 summarizes the capabilities of a SOI to meet new business expectations.

Table 1. SOI and New Business Expectations

Business Requirement	Service Oriented Infrastructure
Enable Business Agility	• Applications and services can be deployed and scaled in a timely manner, without requiring time-consuming acquisition, replacement, and deployment of application-specific infrastructure. • Computing resources can be dynamically redeployed between production and nonproduction environments to meet planned or unplanned changes in business priorities. • Major changes such as restructuring, mergers, acquisitions integration, and business process change can be accommodated in a timely, cost-effective manner.
Control Costs	• Standardizing, consolidating, and virtualizing server, storage, and network resources greatly improves utilization levels and can free large reserves of wasted capacity. Standardization and increased resource efficiency lead to a notably lower data center TCO and a reduction in the TCO of each new application that is deployed. Adoption of industry-standard compute resources offers improved price performance.
Improved Energy Efficiency	• Energy requirements for data centers continue to rise, but organizations understand that energy efficiency is currently very low. Today, on average, only 1.5% of each watt of electricity generated to power a data center actually delivers useful CPU cycles. SOI substantially improves computing, storage, and network utilization, thereby substantially increasing data center energy efficiency.
Facilitate Regulatory Compliance	• Centralized policies in the infrastructure services layer can easily be inspected and monitored. • Decentralized enforcement of policies helps ensure consistency throughout the organization. • Centralized data storage facilitates and accelerates audits.
Support Application Service Levels	• Pooled data center resources can be used to provide redundancy and reserve capacity that supports high availability and adequate performance to critical business applications. • Pooled resources and virtualization also allow the consistent protection of data and applications through global secure access control as well as tiered business continuance and disaster recovery practices that span pooled application and hardware resources. These infrastructure-wide solutions result in fewer disruptions, a faster recovery from disruptions that do occur, and enhanced overall application performance and lower costs.
Enable Effective Information Management	• Creation of a common shared storage network and centralized storage management software allows the entire pool of information and storage resources in the SOI to be consistently provisioned, protected, archived, and when appropriate retired. Information management provides automated management of the storage hierarchy, control of information dissemination, data replication, and business continuity protection. • Additional benefits include facilitating information storage for regulatory compliance, maximizing resource utilization, enabling the rapid deployment of new applications, and more timely response to changing business conditions.

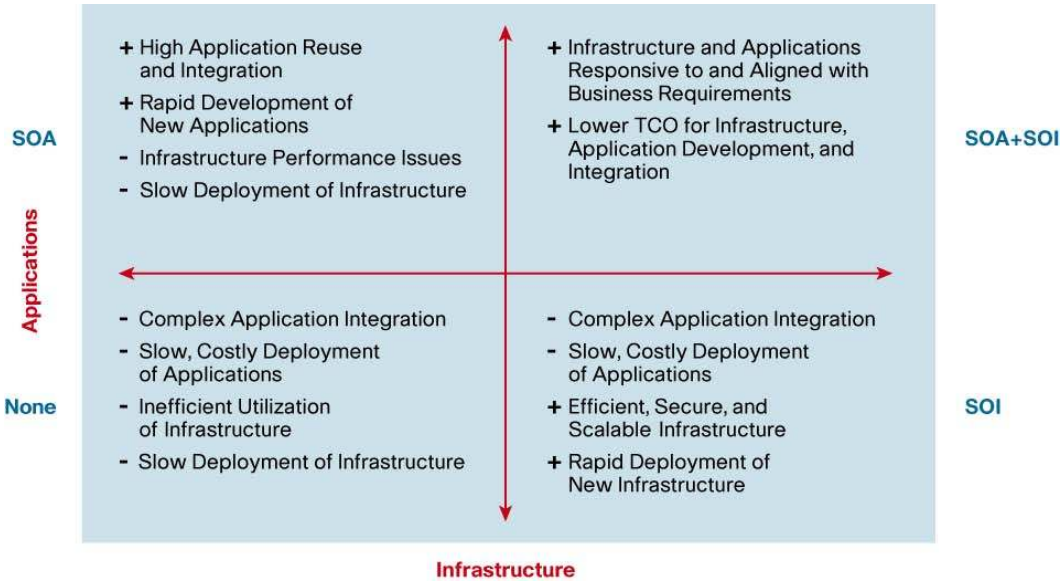
Why Building a SOA on an SOI Makes Sense

Launching a SOA solution is typically a multiphase, multiyear activity that requires IT to make significant technological and organizational changes.

From a technology perspective, building this new, integrated, enterprisewide application architecture on traditional infrastructure can be compared to constructing a new office building on old foundations. Services offered as part of a SOA must be accessible, deterministic, secure, and reliable. The highly granular and distributed nature of Web services makes SOA applications more dynamic, decentralized, and asynchronous than traditional applications. Infrastructure that is not adaptive will rapidly cause performance slowdowns. In addition, traditional infrastructure, lacking a federated infrastructure services layer, makes consistent security, service levels, and overall availability difficult to provide.

Although SOA and SOI can be pursued as independent strategies, combining them offers many benefits, as illustrated in Figure 2.

Figure 2. Compounded Benefits of Combined SOA on SOI



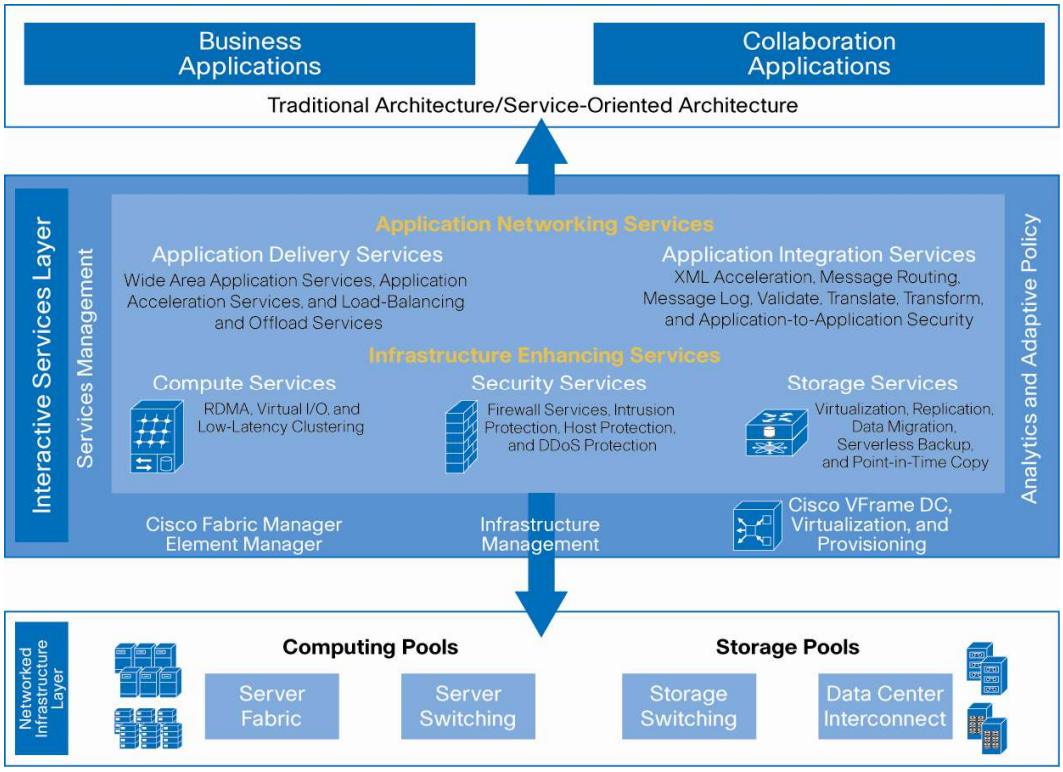
In addition to providing cost savings, SOI provides a dynamic infrastructure foundation to support the SOA dynamic application model. Customers implementing a SOA strategy should view SOI as an important enabling foundation.

Networking Requirements for Implementing an SOI

Sharing infrastructure resources to support the dynamic deployment of SOA applications requires the capability for all infrastructure resources to be dynamically aggregated and segmented to create secure computing and storage environments. The network is the only common element in the infrastructure foundation capable of interconnecting, aggregating, and securing all devices, servers, and storage components. A properly planned data center network protects application and data integrity, optimizes application availability and performance, and enables responsiveness to ever-changing service deployments.

Cisco Service-Oriented Network Architecture (SONA) provides a framework for implementing an SOI strategy. The Cisco data center network architecture, illustrated in Figure 3, highlights the components of Cisco SONA that relate specifically to the data center. It supports both traditional application architectures and SOA.

Figure 3. The Cisco Data Center Network Architecture Based on Cisco SONA



The two layers of the SOI are clearly represented:

1. **Networked infrastructure:** The foundation of the data center network architecture provides intelligent connectivity services for networked elements such as servers, devices, and storage, as well as for external users or other data centers. The network fabric is built with highly resilient, scalable platforms that integrate intelligent services directly into the fabric.
2. **Interactive services:** This layer provides the infrastructure services of SOI integrated into the network where they are appropriate. These services facilitate the implementation of an SOI by enabling the dynamic creation of secure application environments and the delivery of those applications to the end user. These infrastructure services allow centralization and standardization of heterogeneous services that were previously available only as distributed services on end systems such as servers and storage devices. These centralized, network-based services enable unified administration, improved performance, and more freedom of choice regarding which end systems to deploy. Following are a few examples of these intelligent services:
   - Storage services such as storage virtualization, write and tape acceleration, and network-accelerated serverless backup, which enhance provisioning flexibility and business continuance capabilities integrated into the network where they are appropriate
   - Security services such as adaptive threat defense, virtualized firewalls, and host-based intrusion detection, which help ensure that infrastructure consolidation and virtualization initiatives can be achieved securely
   - Application delivery services, which allow infrastructure to be consolidated in centralized locations, making the effective delivery of applications to remote users even more critical

- Application integration services (application caching and XML processing), which enhance the delivery of applications to the end user as well as communication between application tiers, different applications, and business services
- Service orchestration services, which enable the coordinated provisioning and reuse of physical and virtualized computing, storage, and network resources from shared pools, using the network to help ensure that applications are dynamically supported throughout the infrastructure

The design of an appropriate data center network architecture provides IT organizations with the foundation required to take a phased approach to SOI implementation. The phases can include resource consolidation, virtualization, and automation. Many IT organizations already have begun to consolidate storage resources, which can then be shared across a data center network fabric. Likewise, efforts to consolidate and standardize underutilized computing resources by running multiple applications on a single physical server are well underway. Virtual machine hypervisors, such as VMware, Xen, and Microsoft Virtual Server products, allow underutilized servers to support multiple applications concurrently.

Data center virtualization is widely acknowledged as the next important phase in IT's evolution to a SOI. Virtualization allows services to be decoupled from the underlying physical infrastructure and physical resources to be partitioned into multiple logical resources. The concept of virtualization is being applied to all data center technology domains today, including server, storage, and network.

Although the most immediate motivations for virtualization are improved resource utilization and lower costs, the ultimate goal is to use the abstraction between applications and infrastructure to manage IT as a service. Virtualization can be considered the foundation for orchestrating services across all data center technology disciplines. It is essential for creating an infrastructure environment that enables the flexible, reliable, and secure rollout and scaling of SOA application services.

Cisco is taking active roles in both delivering network virtualization and providing a network platform for the secure, scalable virtualization of servers and storage. In addition, Cisco is now helping IT administrators orchestrate the dynamic provisioning of services across all three virtualized domains. The industry's first service orchestration solution to use the ubiquity of the network, Cisco VFrame Data Center (DC) can achieve cross-technology orchestration, enabling customers to progress further toward an SOI.

Cisco VFrame Data Center (DC) Enables Implementation of an SOI

Until now, efforts to consolidate and virtualize the data center have been planned and administered in separate technology domains: individually by the server, storage, and network teams, even though applications themselves use a combination of all three resources. Treating server, storage, and network infrastructures as separate domains requires constant manual configuration and realignment among the three, leading to long lead times for application provisioning, scaling, and recovery. Furthermore, as the number of managed networked entities continues to grow and as more of these resources are virtualized, the act of connecting computing, storage, and network services in a secure and repeatable fashion becomes more complex and costly and less manageable, eliminating much of the benefit initially realized from virtualization. Until there is a better way to achieve alignment across these technology domains, server, storage, and network managers will continue to face these data center realities:

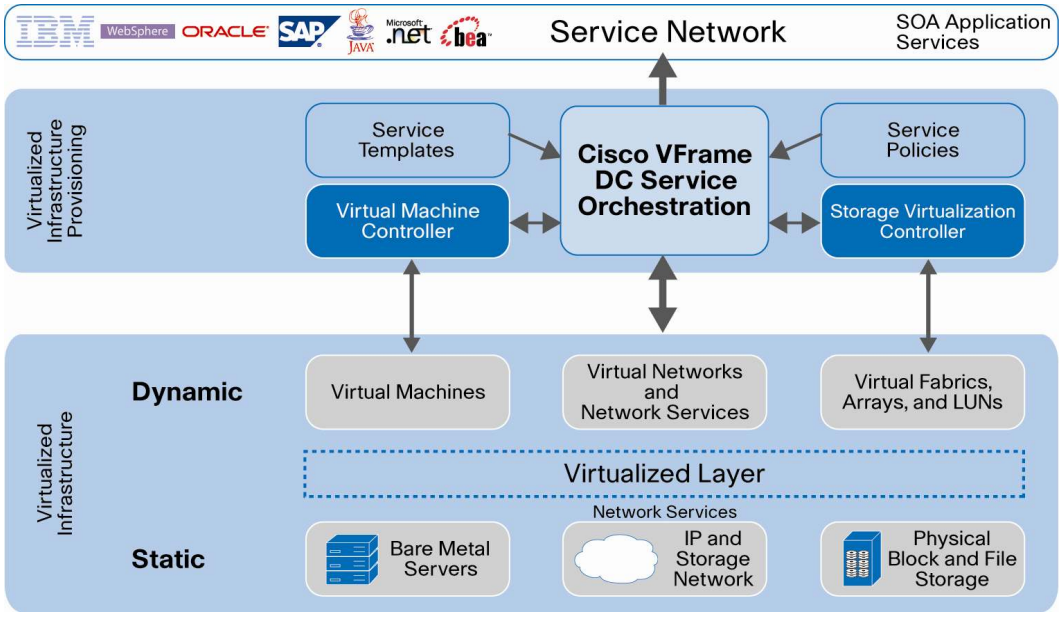
- Inability to quickly provision new applications or SOA application services because of the siloed, uncoordinated nature of data center operations
- Insufficient flexibility to keep pace with increasingly dynamic business requirements as the rate of application change accelerates
- Proliferation and low utilization of resources, caused by the static and rigid mapping of applications to infrastructure elements
- Long failure recovery times unless costly redundant systems and break-fix support agreements are implemented

To address these challenges, proactive, coordinated provisioning and reuse of physical and virtualized infrastructure resources are needed. A solution with these features would provide a common way to allocate resources to applications and SOA application services, based on operational best practices and business priorities and would dramatically improve both initial provisioning and the modification or recovery of existing applications in response to changing requirements and events.

Recognizing the need for coordinated provisioning and orchestration of these networked resources as services, Cisco is working to help IT organizations address these requirements and advance the data center infrastructure.

Cisco VFrame DC is a service orchestration solution that enables the coordinated provisioning and reuse of physical and virtualized computing, storage, and network resources from shared pools, using the network to help ensure that applications are dynamically supported throughout the infrastructure (Figure 4).

Figure 4. Cisco VFrame DC Service Orchestration Framework

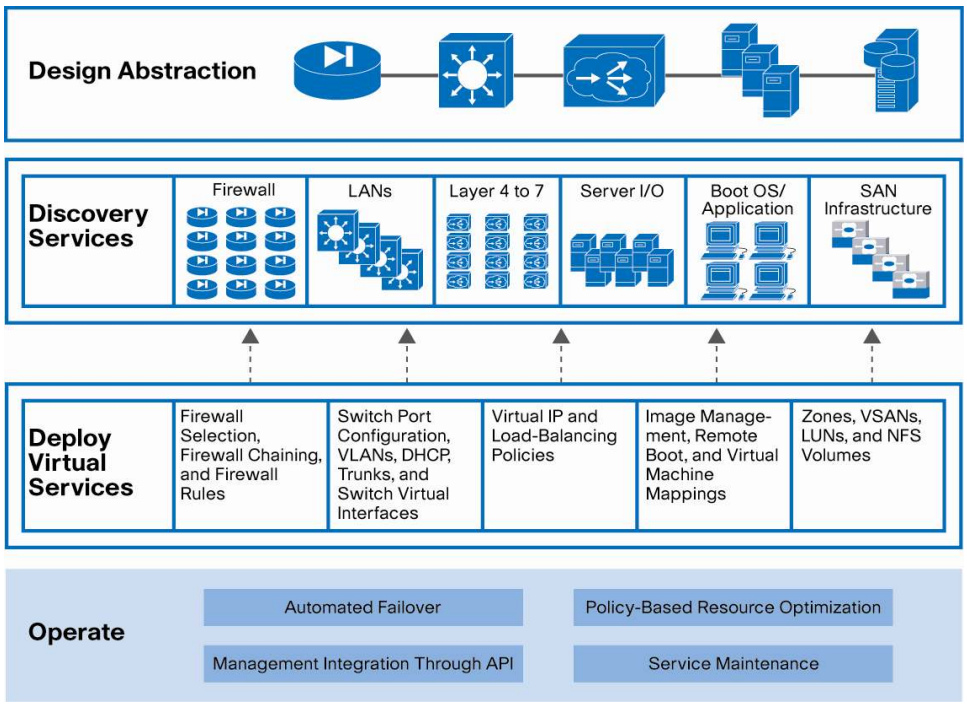


The appliance-hosted VFrame DC software functions can be divided into four categories that reflect the service orchestration process: design, discover, deploy, and operate:

- **Design:** In this phase, logical infrastructure service templates describe the server, storage, and network resources and topology required to host a specific application service. These reusable templates present the rules by which applications are supported with data center resources.
- **Discover:** Available networked physical and virtualized resources are detected and pooled based on attributes such as performance, capacity, and availability.
- **Deploy:** Services are instantiated based on the requirements that Cisco VFrame DC defines in a service template and the resources it discovers. Cisco VFrame DC applies a service template to a specific application requirement, by orchestrating the provisioning of a service network from the available shared pools of server, storage, and network resources (Figure 5). When the service is ready to be decommissioned, Cisco VFrame DC unconfigures and returns the resources to their pools.
- **Operate:** Common operating tasks such as failover, policy-based resource optimization, and service maintenance are automated using Cisco VFrame DC, which also integrates with other system management systems through the Web services interfaces.

Cisco VFrame DC follows a simple workflow that gives data center administrators the necessary abstraction between the logical resources that are needed for applications and the physical resources that power them.

Figure 5. Orchestration Between Design and Operations



A network-oriented approach to service orchestration offers exceptional visibility and control across all heterogeneous networked data center infrastructure resources. The data center network provides a platform for the orchestrated provisioning of both physical and virtualized resources and enables a wire-once approach that reduces manual intervention and increases flexibility across all technology domains.

- **SOI visibility:** Provides visibility and access to all networked data center resources and services for discovery, provisioning, and configuration

- **Connectivity awareness:** Has access to the physical and logical relationships, connections, and topologies between resources so that they can be assembled into meaningful application services
- **Dynamic associations:** Allows resources that would otherwise be static and isolated to be dynamically controlled and connected into logical services without manual intervention
- **Security and isolation:** Through the in-depth security and isolation that only the network can apply dynamically, provides protection for shared services provisioned to any application, workgroup, or company

Overall, Cisco VFrame DC facilitates less expensive, faster, and more reliable infrastructure in the short-term and gives data center operations a pragmatic path toward SOI. Cisco VFrame DC enables increased levels of collaboration and alignment among previously siloed server, storage, and network infrastructure domains. Cisco VFrame DC is best used as a collaborative tool to help organizations better utilize resources, align the infrastructure more closely with ever-changing business requirements, and ultimately achieve the full benefits of a service-oriented approach.

Cisco VFrame DC consists of a high-availability appliance, a Java-based software application, and a Web services API that are used by server, storage, and network operations teams to provision and reuse infrastructure components.

The power of Cisco VFrame DC comes from its ability to orchestrate existing physical and virtual data center resources. Cisco VFrame DC is designed to be interoperable and fully integrated with most commonly deployed server storage and network platforms. This interoperability applies both downstream to underlying server, storage, and network resources, and upstream through the API to packaged and in-house management and automation tools. Cisco VFrame DC is designed to complement existing investments in consolidation and virtualization, orchestrating virtualized resources such as networks (for example, virtual storage area networks [VSANs], VLANs, and virtualized firewalls), servers (for example, hypervisors and virtual machine technologies), and storage (for example, network-hosted storage virtualization).

Conclusion

IT organizations should consider SOA and SOI as two complementary, closely connected initiatives that, in combination, provide outstanding business responsiveness and efficiency. As discussed in this document, the significant business value offered by a SOI is enhanced when it is used to support a SOA.

A successful SOI deployment requires a robust network platform such as that provided by the Cisco data center network architecture. The deployment of the appropriate network architecture allows IT organizations to deploy a SOI in phases to address critical concerns along the way.

In addition, the full benefits of an SOI are experienced only when the provisioning of physical and virtualized server, network, and storage infrastructure domains is coordinated transparently. By using a network-oriented service orchestration solution such as Cisco VFrame DC, IT organizations can extend the value of SOI beyond cost savings, enhancing the dynamic nature of SOA and the organization it supports.

For More Information

For more information about the complete Cisco portfolio of data center networking offerings, visit the Cisco Web site at http://www.cisco.com/go/datacenter.

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