EXECUTIVE SUMMARY

Cloud computing is increasingly being investigated and adopted by companies with the goals of lowering costs, reducing time-to-market, and changing the pattern of IT investment.

Companies have also found that private clouds (infrastructure providing the cloud characteristics of self-service provisioning and de-provisioning of infrastructure on a real-time basis deployed within the corporate firewalls or data centers) help them achieve their goals while eliminating the inherent security, governance, cost and service-level risks associated with public cloud providers.

The FlexPod™ solution with VMware® vSphere® is an integrated solution of hardware and software components from NetApp, Cisco and VMware that provides the foundation for a private cloud infrastructure. It allows a company to achieve the goal of self-service infrastructure provisioning on a real-time basis deployed within the corporate firewalls and data center.

In particular, the FlexPod solution has been found to be exceptionally effective for companies that require extensive development and test environments, and have test and development resources deployed around the world.
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1 INTRODUCTION

In the infancy of the IT era, new software, hardware, and operations procedures were implemented directly into customer production fulfillment systems without strong governance, risk management or controls in place, or without much knowledge of the adverse impacts these changes might have on the company’s customers.

It was a game of Russian roulette. The lack of controls sometimes wreaked havoc on customers. Customers, revenue and jobs were lost. Companies quickly recognized the need to protect their customers and isolate production systems from untested new technologies.

Fast-forward to the present: Most companies cannot provide services without significant dependence on IT. Portals, billing, relationship management, telecommunications, Internet and business function application systems are just a few examples of systems that are a requirement for most companies. Overall investment in IT and IT staffing (employee, contract, and outsourced) have both grown as a percentage of overall corporate budgets.

Company operations are now dependent upon many different application, software, hardware, telecommunications and network infrastructure technologies, all of which reside within an internal or outsourced data center. Data centers have become more complex and fulfill more requirements.

New technologies (applications, software, hardware, telecommunications, and network) are now tested and implemented on a monthly—if not weekly—basis. These rapid changes necessitated more mature models of governance such as ISO and COBIT standards.

The gross number and total percentage of developers and testers in companies have increased. Development and testing are now deployed worldwide instead of being physically anchored near the infrastructure. The ratio of developers and testers to infrastructure administrators who provision the environments has increased. Testing environments have morphed into “sandbox,” unit, acceptance, string, stress, performance, system, and functional test environments.

Demands for higher-quality software development and systems implementations, and the need to identify issues earlier in the test process, have increased the demand on developers to perform more testing during their software development process—which in turn has led to more-powerful infrastructure being made available to developers.

Overall, this has led to an enormous increase in the demand and scale of development and test environments within companies and throughout the world. This demand has resulted in increased investment in development and test infrastructure, and the need to provision this infrastructure more rapidly.

None of this has changed the fact that companies still operate by the mantra of “revenues up, costs down” as they persistently look for ways to deploy technology “better, faster and cheaper” for the good of the company.

The latest IT evolution for deploying infrastructure “better, faster and cheaper” is cloud computing.
For the purpose of this white paper, a cloud solution will be defined as one that provides a unit
of compute resource (CPU, memory, storage or virtual operating system) that can be
provisioned and de-provisioned on an “on-demand” basis by the users of that compute resource
(in addition to the traditional administrators), regardless of where the users or the compute
resources physically reside. The cloud solution can be tracked at a unit-compute level.

The cloud solution can be delivered via:

- A public cloud (over the Internet by a third party such as Amazon, Google, Microsoft)
- A third-party private cloud (over a private network by an outsourced party such as Terremark),
  or
- An internal private cloud (within a company’s in-house data center)

Because they represent a major operating-budget cost, but don’t directly service customers,
development and test environments are excellent candidates for migration to cloud solutions as
a means to realize the promise of “better, faster, cheaper.”

However, depending on the complexity and requirements of a company’s business, operations,
regulatory environment, corporate policies, IT infrastructure, applications and forensic research,
governance and controls, data security, intrusion protection and many other factors, much risk
can exist in migrating development and test environments to external third-party public or
private cloud providers.

The challenge is so great that many of these providers can’t—or won’t—contractually provide
for the service levels, governance and controls, and/or security required. These variables can
eliminate third-party cloud providers as viable solution options, leaving the internal private cloud
as the only available choice to explore.

Internal private cloud technology can:

- Lower the cost of the unit-compute resource
- Provide for more-rapid provisioning and de-provisioning of unit-compute resources on an ad
  hoc basis, and
- Achieve a higher utilization of existing compute resources and therefore lower future capital
  investment while still meeting the company’s service-level, governance and control, and
  security requirements.

Private cloud technologies also allow companies to take advantage of the convergence of
network, server, storage, server and desktop virtualization, and telecommunications, which can
result in a more-flexible and denser data center.

One of the leading private cloud solutions that allows these benefits to be achieved is FlexPod;
a joint offering from Cisco and NetApp. This white paper will review this solution and its impact
on development and test environments.
2 WHAT IS FLEXPOD?

FlexPod is a predesigned, prevalidated base configuration that is built on the Cisco® Unified Computing System™ (UCS™), Cisco Nexus® data center switches and NetApp® FAS storage components, and includes a range of software partners. FlexPod can scale up for greater performance and capacity, or it can scale out for environments that need consistent, multiple deployments.

Some examples of the different use cases are presented in the diagram below.

**Figure 1) VMware vSphere built on FlexPod components:**

The requirements of many functional use cases can be satisfied because many software solutions can be layered on top of—and integrated into—the FlexPod architecture. Examples of solutions that have been built on top of and integrated with FlexPod, which can be served individually or in combination, include:

- VMware vSphere
- VMware View™
- SAP® Applications
- Microsoft® Exchange
- Microsoft SQL Server®
- Microsoft SharePoint®
- Secure Multi-Tenancy
- Red Hat® Enterprise Linux
- Secure Separation

VMware vSphere on FlexPod will be the focus of this white paper.
3 WHY IS FLEXPOD SO VALUABLE FOR DEV AND TEST?

Development and test environments are outstanding candidates for FlexPod, as it is a technology that truly allows a company to lower its capital investment while increasing the utilization of its resources, improving its capabilities, and operating more rapidly, flexibly and efficiently.

This technology lends itself to rapidly provisioning infrastructure for test and development environments for new projects, and then redeploying these resources to other initiatives when necessary. It allows companies to more rapidly spin up test environments and scenarios, thus reducing test preparation time.

The benefits for the development and test environments are enormous:

- **More efficient data center**
  - Denser environments can be deployed, so less data center space is utilized
  - NetApp's built-in storage efficiencies such as dedupe, thin provisioning, and rapid cloning can reduce the amount of storage required by 50%
  - Unified architecture and fabric with a single unified 10GbE network, running SAN and NAS protocols, including FCoE
  - Extended memory technology allows UCS to support up to 384 Gigabyte memory with 60% reduction in the cost of memory
  - Simplified processes to manage a pool of compute, network and storage resources in a single platform, and radically simplified architecture to reduce the number of devices to be purchased, cabled and powered
  - Multiprotocol storage systems

- **Faster testing life cycle**
  - Environments can be set up and torn down faster
  - Environments can be provisioned and de-provisioned more rapidly
  - Consistent environments can be replicated more rapidly
  - Common repositories for test cases and scripts can be more easily maintained
  - The ability to replicate consistent environments simplifies the customization of environments, test cases and scripts
  - Controls for automated test execution are improved
  - More-efficient management and execution of optimal test beds can be achieved
  - The management of test results is improved
  - Testers can easily spin up 3-tier architectures of a load-balance, app server layer, and database server
  - Unit, string, integration, system, user acceptance, stress and performance, and disaster recovery testing all become simpler to perform

- **Faster development life cycle**
  - Developers and testers can more easily share their environments and test results, shortening the development life cycle
  - Developers can provision "all-in-one" environments in which a single machine runs a single stack of OS, application server and database
  - Debugging and troubleshooting time is reduced
  - The entire state (memory, network settings, disk, server settings) can be more easily saved as a template
• **Cost reduction**
  - Utilization of compute resources is increased, reducing capital investment
  - The time and cost to rewire lab technologies is reduced
  - Resources can be shared more easily between departments
  - Virtual labs can be deployed more easily, reducing the number of physical labs
  - Users of the environment can be monitored, controlled and “costed” more easily
  - The overall portfolio of technology that needs to be supported will be reduced
  - Capacity can be scaled up and down more rapidly
  - Resources worldwide can more easily share technologies and collaborate

• **Disaster Recovery and Business Continuity**
  - Redundancy and high availability can more easily be implemented and tested
  - These environments can be more easily utilized as back-up environments
  - SnapMirror, SnapProtect, SnapVault and SnapLock help maintain availability during planned and unplanned downtime

• **Monitoring and administration**
  - End-to-end monitoring of storage, server, hypervisor, and network components is more cohesive and streamlined

• **Customer service benefits**
  - Customer use cases and issues can more easily be replicated providing improved customer service
8 FlexPod for Global Dev-Test Environments

4 VMware vSphere built on FlexPod

VMware vSphere built on FlexPod is a private cloud infrastructure that allows users of the environment to self-provision and de-provision virtual machines on a real-time or ad hoc basis. Self-provisioning and de-provisioning is defined as the user having the ability to provision a specified amount of compute resource (i.e. virtual machine, OS, storage, specific software and data environments implemented on the baseline infrastructure).

Many variations of the FlexPod infrastructure can be utilized depending on the use case. One example of a baseline FlexPod configuration is illustrated in Figure 2.

Figure 2) VMware vSphere built on FlexPod components:

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Cisco Unified Fabric

The Cisco Nexus 5500 series switches provide a unified, high-speed fabric for connectivity. Figure 2 illustrates FlexPod connectivity for a) FlexPod FC and 10 GbE Based Architecture and b) FlexPod FCoE and 10 GbE Based Architecture.
Figure 3) FlexPod FCoE and 10 GbE-based architecture¹:
Figure 4) FlexPod FC and 10 GbE-based architecture¹:

Figure 3 and Figure 4 outline the possible NetApp Controller interconnect choices. The first topology in Figure 3 is an FCoE-only implementation, while the second in Figure 4 adds the option of native FC connectivity. These interconnects are not interdependent and may be deployed together or separately to meet customer hypervisor or application support requirements. Both deployments are fully supported.¹

The default hardware is detailed in the FlexPod technical specifications and includes two Cisco Nexus 5548 switches, two Cisco UCS 6120 fabric interconnects, and three chassis of Cisco UCS blades with two fabric extenders per chassis. Storage is provided by a NetApp FAS3210CC (HA configuration within a single chassis) with accompanying disk shelves. All systems and fabric links feature redundancy, providing end-to-end high availability. This is the default base design, but each of the components can be scaled flexibly to support a specific customer’s business requirements. For example, more (or different) blades and chassis could be deployed to increase compute capacity, additional disk shelves could be deployed to improve I/O capacity and throughput, or special hardware or software features may be added to introduce new features (such as NetApp Flash Cache for dedupe-aware caching).

¹ FlexPod Deployment Guide. 8/31/2011 Cisco Systems, Inc.
Two networking components are specifically designed to support VMware:

**Cisco Nexus 1000V virtual supervisor module (VSM)** is a software switch that runs within the VMware kernel or on the Cisco Nexus 1010 appliance to provide tight integration between the server and network environment.

**Cisco Nexus 1010** is a dedicated appliance that supports multiple instances of the Cisco Nexus 1000V VSM to offload work from individual server blades, improving scalability and performance.

**Cisco UCS Platform**

All Cisco B-Series blades are supported within the FlexPod architecture. For example, a FlexPod reference architecture might include the B-Series B200 M2 Blade Server for general workloads and the B250 M2 Extended Memory Blade Server for memory-intensive workloads. The B250M2 offers more than double the memory capacity of a standard two-socket server design, to meet the needs of demanding virtualization environments and large dataset applications.

**NetApp FAS3210A**

All NetApp FAS controllers that support 10GbE are supported within FlexPod. For example, a FlexPod reference architecture might include the NetApp FAS3210A storage system with a dual-controller configuration that includes 42TB of SAS storage and 512MB of Flash Cache for intelligent caching that offers significant acceleration for server and desktop virtualization and other applications. Or it might be configured to take advantage of the FAS3210A’s ability to achieve high levels of storage efficiency using NetApp technologies such as RAID-DP®, deduplication, thin provisioning, FlexClone®, and others. FlexPod also supports the FAS62XX series storage system for more complex, higher end requirements.

**NetApp Data ONTAP® 8.0.1**

The combination of the NetApp Data ONTAP operating system and NetApp FAS storage systems provides even higher levels of performance, manageability and reliability for large clusters. The solution includes multinode scaling using a global namespace, NetApp FlexVol® storage virtualization, clustered file system, Snapshot™ replication and mirroring, and RAID-DP technology.

Data ONTAP 8.x systems are based on FAS 30x0 and FAS 60x0 systems as well as all current controller models. You can add up to dozens of FAS controllers and storage as needed to scale to multiple gigabytes per second of throughput and petabytes of capacity.

**VMware Components**

VMware vSphere built on FlexPod includes VMware vSphere Enterprise Plus and VMware vCenter™. Capabilities such as vMotion™, Storage vMotion, and Distributed Resource Scheduler are included.
For element management, FlexPod for VMware includes three components:

- **VMware vCenter** provides a scalable and extensible management platform that supports workflow automation.
- **Cisco UCS Manager** provides embedded management of Cisco components and integration with vCenter.
- **NetApp OnCommand Management Suite** lets you delegate storage management tasks to server or VMware administrators and also provides vCenter integration.

Some of the Role Based Access Control (RBAC) is supported across all three element managers. This allows different administrators to have different rights depending on their job function.

Many data centers have standardized on a system management stack, or are planning on doing so. To facilitate integration into existing management frameworks, each layer in this solution—hypervisor, network, compute, storage—provides open APIs for integration with leading orchestration products.
5 ORCHESTRATION SOFTWARE

The term “orchestration” gets used in so many different contexts during “cloud” discussions, that at times it’s unclear if everyone is talking about the same thing.

Orchestration software is a layer of software over the hardware and hypervisor layers that allows for the management and monitoring of the cloud characteristics and features. For the purpose of this paper, orchestration software is defined as software that allows you to manage the key elements of the private cloud infrastructure.

Because an environment can only be considered a “private cloud” if the compute resources can be provisioned in a real-time or ad hoc manner, at minimum orchestration software must provide the ability to provision the resources.

There are a number of capabilities that might be included in, but are not required for, the orchestration software layer:

- **Portal virtual infrastructure provisioning** allowing for automation of resource provisioning and configuration so users can rapidly build or tear down virtual environments
- **Cloud resource management** allowing tracking of changes to IT resources in real time
- **Virtual network management** allowing for the automation of virtual networks
- **Dynamic capacity planning and monitoring** providing visibility into virtual infrastructure resources consumption
- **Role-based and policy management** enabling IT to administer, monitor and enforce policies
- **Integration with enterprise management systems** such as LDAP and CMDB
- **Unified dashboard and interface** across private clouds, public clouds and hybrid clouds
- **Virtual Machine Management** allowing for the management of the entire VM life cycle based on policies set by administrators
- **VM storage management** allowing for the management, provisioning and monitoring of virtualized storage
- **Monitoring and alerts** providing a view of all resources
- **Chargeback** enabling business units to account, monitor and report resource usage and associated costs
- **Performance management** enabling automated performance monitoring of systems

This is not a comprehensive list of all the features orchestration software might provide, nor does an orchestration software product necessarily provide all of these features.

FlexPod has been designed to allow FlexPod customers to choose and integrate different tools rather than being forced to use one specific tool.

There are two layers of orchestration partners:

- **FlexPod Management Solution partners** choose to manage FlexPod components by their individual device element managers. The FlexPod ecosystem brings together customers and partners with solution vendors to enable them to get the most of out their FlexPod infrastructure. The FlexPod management solutions offer a wide range of solutions to simplify the management and operations of the FlexPod infrastructure and workloads built on it. These solutions include streamlining the deployment of FlexPods, orchestrating service delivery, and self-service IT.
• **FlexPod Management Validated Solutions partners** follow prescriptive guidelines that enable standardized management of shared FlexPod infrastructure in a way that enables FlexPod to snap into the existing solutions of partners. These partners have their solutions validated by Cisco and NetApp. Vendor offerings designated “FlexPod Management Validated Solutions” provide the additional benefit of tight integration with the FlexPod components and solution validation by Cisco and NetApp.

Cloupia is an example of a vendor whose solution is validated, and is now considered a member of the FlexPod Management Solution tier by Cisco and NetApp. Gale Technologies and Computer Associates are currently members of the FlexPod Management Solution tier, and are pursuing the FlexPod Management Validated Solution tier.

- **Cloupia** provides a “single pane of glass” cloud management capability for both physical and virtual resources in private and public cloud instances.
- **Gale Technologies** provides orchestration and automation solutions for the engineering environments, allowing technical staff to create lab environments “on demand.”
- **Computer Associates** will be integrating the management of FlexPod’s shared infrastructure, provisioning, and orchestration of FlexPod’s resources in their ITSM ecosystem.

The validated solutions provide the assurance that FlexPod is managed in a standardized way, which is perfect for those customers who want to make customized changes to their cloud solutions. Customization is as simple as making changes to the overall management solution, as it is the management pane of glass that is making the calls to FlexPod APIs.
6  FlexPod IMPLEMENTATION CASE STUDY: SOFTWARE COMPANY

Background

A software company was highly dependent on its Quality Assurance (QA) department to successfully deliver major and minor releases to market on schedule, and to deliver new products to market. The QA group comprised a functional testing department, and a stress and performance testing department. The QA department worked very closely with the development teams.

The company certified for customers that it would support the most current major release, two major releases back or two years back. The company certified its product on 63 different flavors of operating systems.

Testers and developers were located in Mexico, Vietnam and Portland, OR. From a scale perspective, the testers would simulate a customer environment of 1,500 servers with their software agents deployed by spinning up 1,200 VMs. The tests were not considered successful unless the storage I/O was 100 IOPS. The test was considered successful if there was a variance of performance across the 1,200 VMs within a certain specified tolerance range.

The development and test teams required the ability to rapidly provision and de-provision VMs and deploy and test standard tests templates. The development and test teams were dependent upon centralized administrators to provision environments for them. They could not provision their own environments. The aging equipment impeded their ability to meet release dates, which was impacting the company’s ability to meet new product rollouts and to leverage the latest technologies that would allow them to improve their test processes.

Client Goals

The client set the following goals:

- Shorten infrastructure provisioning and de-provisioning times
- Decrease testing execution processing times
- Create re-useable testing templates
- Provide increased overall testing and VM capacity
- Reduce contention between departments competing for same compute resources
- Improve the end-user testing experience
- Provide better forensic and diagnostic tools
- Improve the administration and monitoring tools
- Support software product certifications across 65 operating systems
- Shorten product time-to-market
- Increase the utilization of computer resources
Solution

A separate private cloud was developed for both the functional testing department and the performance and stress-testing department. A shared infrastructure environment utilized by both the functional and stress departments to build their environments was designed. The general components of the solution are summarized below:

- **VMware**
  - vSphere Standard
  - vSphere Enterprise Plus
  - vCenter Lab Manager
  - vCenter Standard
- **Servers**
  - UCS 6120 Fabric Extenders, 10 Gb links per FEX
  - UCS 5108 Blade Chassis
  - UCS B200 M2 Blades
- **Storage**
  - SnapRestore
  - NetApp 3270 Controllers
  - PAM II 512GB cards
  - FlexClone
- **Network**
  - Nexus 7010 Switches
  - Nexus 5010 Switches
  - Nexus 2248 Switches

Benefits to Client

- Provisioning of test and development resources were moved from administrators to users, reducing bottlenecks
- Metrics showed:
  - provisioning time was reduced from roughly 42 hours to 15 minutes
  - test preparation and execution times were reduced from 5 days to 30 minutes
  - software product certification environment preparation time was reduced from 5 days to 30 minutes
  - cloning speed increased from 0.2 VMs/minute to 16.8 VMs/minute
- A highly available, fault-tolerant environment
- Improved capacity management and higher utilization of resources
- Faster product time-to-market
- Significant reduction in I/O-bound issues
- Reduced contention for resources between testers and developers
- Improved productivity of resources in Vietnam and Mexico
- Significantly improved load-balancing
- Ability to perform “on the fly” ad hoc emergency debugging
7 CONCLUSION

Private cloud computing has rapidly moved from being an untested theory to an environment of mature solutions that can help meet the goals of cost reduction and faster time-to-market.

As these solutions have matured, the previously nonintegrated and separate hardware infrastructure products have become successfully integrated components comprising virtualization, storage, server, network, and data center.

This maturation has provided an environment in which users deployed throughout the world have the ability to self-provision and de-provision infrastructure on demand, without needing assistance or intervention by an administrator.

These capabilities provide far-ranging benefits, particularly in development and test environments that are so critical to a company’s ability to deploy systems as rapidly and economically as possible.

With mounting economic pressures, solutions that offer lower cost and faster deployment are essential to providing companies with a competitive edge. And VMware vSphere built on FlexPod is just such a solution.

ABOUT THE AUTHOR

Mark Tarmy has been an IT Consultant for Sirius since 2008. He brings more than 20 years of experience to his role. He has worked in the financial services, electronic publishing, Internet commerce, utilities, government, healthcare, retail and manufacturing industries, and has held executive-level positions including chief information officer, chief technology officer, product management, and sales leadership.

Mr. Tarmy was one of the founders of the Sirius cloud computing program that began three years ago, and has been involved in research in, and the practical application of, cloud technologies for a number of years. His experience in cloud computing has ranged from leading designs of internal private cloud solutions with a heavy emphasis on virtualization, to establishing overall strategies, to assessing the viability and risk of utilizing external third-party cloud providers.

With an engineering degree and an MBA, both awarded from Carnegie Mellon University, Mr. Tarmy has helped companies optimize their operations and cost structures and determine the financial payback of their potential technology investment. This experience is complemented by an extensive background in the evaluation of technologies, outsourcing and solutions; software application and database development; off-the-shelf software implementation; infrastructure management, design and implementation; database design, e-commerce delivery; reference architecture development; benchmarking; end-to-end implementation; and many other technologies.