Eight Key Ingredients for Building an Internal Cloud

*VMware Private Clouds: Providing the Ability to Consume Resources, Regardless of Where They Reside*
Table of Contents

Executive Overview .......................................................... 3
What Is Cloud Computing? .................................................... 3
Different Types of Cloud Computing ........................................ 3
A Cloud for Every Business Type ............................................. 4
Cloud Computing Benefits .................................................... 4
Limitations of Existing Cloud Computing Solutions .................... 4
VMware vCloud – Open, Flexible Cloud Computing ..................... 5
Achieving a Successful Federation of Internal and External Clouds ........ 5
Eight Key Ingredients for Building an Internal Cloud .................... 6
Summary ................................................................................. 6
Customer Stories: Leveraging Internal and External Clouds .......... 7
Executive Overview

IT budgets are tighter than at any time in history. But despite severe budget constraints, user demands are still escalating—as they always will. Business cycle times are shortening with increased global competition; all mission-critical applications and services must provide quick and easy scalability, while accommodating growing application access and availability expectations.

Today, investors scrutinize all new investments in IT infrastructure carefully to ensure that they match key business needs and deliver intended results in the most efficient and cost-effective way. To maximize investments, IT organizations are beginning to move away from a device-centric view of IT to an infrastructure that is application-, information-, and people-centric. Enter cloud computing.

Cloud computing technology is driving a fundamental change in today’s computing industry, enabling IT managers to treat infrastructure as a common substrate, on which they can provision services to users faster in a much more flexible and cost-effective way. To maximize investments, IT organizations are beginning to move away from a device-centric view of IT to an infrastructure that is application-, information-, and people-centric. Enter cloud computing.

Cloud computing lets enterprises to do more with the infrastructure they already have, and expand capacity quickly and economically by leveraging external cloud computing resources, when needed.

This white paper reviews the basic fundamentals of cloud computing and examines the limitations of current industry solutions. You will learn about VMware technology and the vCloud Initiative, which are enabling enterprises to move toward a flexible, federated private cloud computing model. Finally, this paper presents the eight key ingredients of successful clouds and concludes with two brief stories about VMware customers WaMu and Marian College, who have successfully adopted various versions of cloud computing.

What Is Cloud Computing?

Cloud computing refers to the use of networked infrastructure software and capacity to provide resources to users in an on-demand environment. With cloud computing, information is permanently stored in centralized servers and cached temporarily on clients, which include desktop computers, notebooks, handhelds, and other devices.

Cloud infrastructure can reside within the company’s datacenters (as internal clouds or on-premise solutions) or externally on the Internet (via external clouds or off-premise solutions). It encompasses any, per-unit-accountable, subscription-based or pay-per-use service that extends IT’s existing capabilities.

Clouds utilize a set of typically virtualized computers that provide users with the ability to start and stop servers or use compute cycles only when needed, often paying only upon usage. By design, cloud computing is scalable, flexible and elastic—offering IT staff a way to easily increase capacity or add additional capabilities on demand, without investing in new and expensive infrastructure, training new personnel, or licensing more software.

Different Types of Cloud Computing

To understand the different types of cloud computing, it can be helpful to look at what the customer actually purchases. There are three different use cases for cloud computing solutions:

1. Application and Information Clouds – Sometimes referred to as software-as-a-service, this type of cloud provides a wide range of business-level services and information to end users. Applications in this space include salesforce.com, Expedia.com and Google Apps.

2. Development Clouds – Sometimes referred to as platform-as-a-service, cloud development platforms enable application authoring and provide runtime environments. Examples of software development clouds include Engine Yard, CohesiveFT, Amazon EC2 and Google App Engine.

3. Infrastructure Clouds – Also referred to as elastic compute clouds or infrastructure-as-a-service, this type of cloud provides virtual hardware capacity to organizations on an elastic basis. Examples of cloud infrastructure providers include Terremark Infinistructure, Amazon Web Services, Hosting.com and Savvis.

All three types of cloud computing solutions can be deployed in either public or private environments:
A Cloud for Every Business Type

- **Public** clouds are accessible over the Internet for general consumption and usually don’t have the same reliability or security required for business applications. These clouds are generally used for temporary development environments or start-up web hosting services.
- **Private** clouds can exist behind the corporate firewall for use by limited, pre-determined audiences, but also can exist off-premise with cloud service providers that deliver secure computing environments. A private cloud enables enterprises to deploy resources to environments that meet the business or application needs, on or off-premise, without concern for reliability or security. The off-premise private cloud is an extension of the internal cloud.

![Diagram of Cloud Types: Private, Internal, External](image)

Cloud Computing Benefits

**Easily expand scalability and enhance elasticity** – Using a cloud computing model, IT staff can meet changing user loads quickly without having to engineer for peak loads. Elasticity is a benefit when enterprises are growing, providing the ability to purchase infrastructure on the margin at predictable costs. Equally as important, the elastic nature of cloud computing provides a way to cost-effectively and quickly scale down a service when it is no longer needed.

**Reduce capital expenditure (CAPEX)** – With external clouds, customers do not own the infrastructure. This enables enterprises to eliminate capital expenditures and consume resources as a service, paying only for what they use. Clouds also enable IT departments to save on application implementation, maintenance and security costs, while benefiting from economies of scale.

**Save energy** – “Going green” is a key focus for many enterprises. Clouds enable IT organizations to reduce power, cooling and space usage to help enterprises create and sustain environmentally responsible datacenters.

**Increase end-user productivity** – Cloud computing increases user productivity because users can access systems regardless of location or device (e.g., PCs, laptops, etc.).

**Improve reliability** – Cloud computing can cost-effectively provide multiple redundant sites, facilitating business continuity and disaster recovery scenarios.

**Free up capacity to invest in new projects** – Moving applications out to a cloud frees up existing infrastructure and resources that can be reassigned to more strategic tasks.

Limitations of Existing Cloud Computing Solutions

Many of today’s cloud computing solutions have serious issues, such as proprietary application platforms that require extensive redevelopment time to function off-premise, the inability to move to another provider if SLAs aren’t met, and long lead times to move or set up new environments. The widespread adoption of cloud computing has been hindered by the limitations of these ineffective solutions, including:

**A lack of interoperability between compute clouds** – The absence of standardization across cloud computing platforms creates unnecessary complexity and results in high switching costs. Each compute cloud vendor has a different application model, many of which are proprietary, vertically integrated stacks that limit platform choice. Customers don’t want to be locked into a single provider and are often reluctant to relinquish control of their mission-critical applications to service providers.

**Lack of compatibility with existing applications** – Many existing cloud technologies do not provide inherent compatibility with existing applications. Some current compute clouds in the public domain have sacrificed application compatibility in order to provide better scalability and other features. What this can potentially mean is that IT has to write entirely new applications specific to that compute cloud, or, at the very least, make very significant modifications to their existing applications before they will run in the compute cloud.

**Inadequate security** – By design, most external cloud vendors typically support multi-tenancy compute environments. IT managers must look for the right balance between the security of an internal, dedicated infrastructure and the improved economics of a shared, external cloud environment.
VMware vCloud – Open, Flexible Cloud Computing

The VMware vCloud initiative delivers the only cloud solution built on the reliability and advanced technology of VMware products and the company’s robust partnerships. VMware vCloud brings enterprise-class cloud computing to all enterprises by federating compute capacity on demand between virtual datacenters and cloud service providers to support existing and new application loads.

VMware vCloud brings three unique characteristics to cloud computing, designed to serve the needs of all businesses that want production-level performance and reliability, on and off premise:

- Maximum choice and flexibility: VMware has partnered with hundreds of cloud service providers to enable delivery on a common VMware platform. This gives users a wide range of choices of where they can deploy applications, and allows easy transitions between providers, as well as on- and off-premise use.
- Enterprise-ready clouds with federation: VMware leverages a familiar and proven platform and management solution that is already used by over 130,000 customers and hundreds of service providers to deliver a reliable, extensible and manageable cloud infrastructure today, both internally and publicly.
- Broadest application support: VMware vCloud enables easy deployment of the largest set of applications to external cloud or on-premise environments with the lowest cost and highest reliability. Additionally, with over 1,000 virtual appliances in the VMware virtual appliance marketplace and hundreds of cloud providers, deploying applications to the cloud has never been easier. More importantly, the applications that already run in the business today will work the same in the cloud, without recoding or building them on a cloud-only platform, saving time and valuable development resources.

Achieving a Successful Federation of Internal and External Clouds

Obtaining the benefits of cloud computing does not need to be an ‘all or nothing’ situation. The most effective scenario is to provide the enterprise with the ability to create a federated environment of internal and external clouds. With this model, IT managers can make intelligent and flexible decisions about which parts of their application loads they want to run internally and which parts externally – and then have the ability to change their minds quickly and easily as the business goals evolve.

When considering cloud options and federation, there are three elements that should be considered. When moving applications to the location that makes the most business sense, whether for costs or SLAs, you should consider:

1) Where you want it.
2) Where it’s going.
3) How it will operate.

The reliable stack – where you want it

The need to look at the cloud is real – new datacenters are extremely expensive and IT budgets are tighter than ever. With vCloud, enterprises now have the ability to decide if they want to carry capital expense internally or leverage external cloud infrastructure for specific company applications in an operating expense model. By leveraging VMware’s reliable virtualization platform and management stack, enterprises are seeing cost savings and efficiencies through not only consolidation, but automation and optimized management. This functionality is allowing them to model their internal infrastructure as a cloud. Additionally, as they look for external providers, leveraging their trust in VMware ensures the external cloud will be interoperable with their internal cloud, making it simple to flex capacity, outsource test and development or leverage clouds for disaster recovery.

Figure 2: The VMware vCloud initiative delivers cloud innovation and the broadest application compatibility through an enterprise-class virtualization and management platform that can be accessed on or off premise via hundreds of cloud service providers.
The trusted location—where it’s going
Unlike other cloud models that have one large datacenter you buy into, VMware’s distributed model leverages the expertise and investments of hundreds of service providers worldwide, including some of the most trusted and biggest names in the hosting and telco business. These providers are working closely with VMware to transform parts of their trusted infrastructure, like cabling and security, to deliver flexible, reliable and proven compute capacity.

Leading the way—setting the standard
Lastly, VMware leads the innovation curve on virtualization, which has created the foundation for what is possible in cloud computing today. As cloud computing continues to define the terms and benefits it will deliver, VMware is working closely with technology leaders in many categories to define standards and set the stage for the open cloud. This solution will deliver many benefits, including enhancing solutions for enterprises looking for federated private clouds.

Eight Key Ingredients for Building an Internal Cloud
There are eight key ingredients to consider when building an internal or external compute cloud:

1. **Shared Infrastructure.** IT staff needs to understand how to configure the underlying storage and networking so that when it is brought together it can be shared across all of the enterprise’s different workloads. They also need to determine where in that shared infrastructure they should delineate between different users on that infrastructure.

2. **Self-Service Automated Portal.** It is essential to make sure that the compute cloud can be consumed in an easy form by both developers and IT professionals. There is a need for self-service capabilities, and for highly automated provisioning portals that provide the ability to add workloads without having to go through all of the many different steps of provisioning with the network and underlying storage.

3. **Scalable.** An effective cloud solution has to be scalable. IT organizations should think about boundary conditions in a more creative way, instead using the traditional models of scalability. As a new workload request comes up, they must determine where to provision that specific workload.

4. **Rich Application Container.** Clouds need to have a richer application container that will show the different interdependencies between components of the application, specifically those that take place between different virtual machines. This information help create the correct network subnets so that the storage will work well together and not be isolated from one another.

5. **Programmatic Control.** It is very common for a compute cloud to have programmatic control. Some of the more popular compute clouds on the market today have made good use of an API called REST. REST is a very simple HTTP-based protocol that provides the ability to manipulate stateful objects in a clear way.

6. **100% Virtual Hardware Abstraction.** Clouds need 100% hardware abstraction. This can include servers or other physical devices like storage. In a cloud environment, the user should be able to interact with the virtual machines and other devices through the user interface, verses actually changing physical infrastructure.

7. **Strong Multi-Tenancy.** Strong multi-tenancy involves extensive use of VLANs to isolate network traffic between different zones in the cloud. This is obviously critical in an external cloud, but also a common requirement in internal clouds, to make sure that authorized users have access to certain applications.

8. **Chargeback.** IT organizations must be able to create effective and accurate chargeback capabilities. For internal clouds, even if funds aren’t literally exchanged, the ability to create transparency in costs and services can help justify expenses.

Summary
Cloud computing is providing enterprises with a fundamentally new way to cost-effectively and quickly deploy services and capabilities. It enables IT organizations to transform the way they operate and dramatically improve how consumers access their information and experience applications. Enterprises that are looking for ways to streamline internal IT operations and to expand on-premise infrastructure to add capacity on demand, as well as organizations wanting a fully outsourced infrastructure, are investigating the many advantages of cloud computing.

The VMware vCloud initiative enables businesses to move to the cloud how they want, when they want, and as much as they want. It allows customers and service providers to extend the boundaries of their datacenters and take advantage of internal and external computing resources seamlessly – to drive down operating costs, concentrate spending on systems that differentiate the business, and ultimately enable IT to become a more strategic asset to the enterprise.

For more information on VMware cloud technology and the vCloud Initiative, please visit http://www.vmware.com/cloud.
Evolution of the Internal Compute Cloud at Washington Mutual

Customer Stories: Leveraging Internal and External Clouds

Many VMware customers have achieved great success with their internal and external cloud deployments. The following sections will examine the cloud development and deployment experiences of two VMware customers, Washington Mutual and Marian College.

Washington Mutual (WaMu), now a division of JPMorgan Chase, started its move to an internal compute fabric three years ago. Barton Warner, first VP and senior group manager and enterprise architect at WaMu, recently shared some insights into how his company has been positioning cloud computing across the enterprise.

“Our business goals included lowering IT deployment and operational costs and obtaining a predictable and faster application model,” stated Warner. “We also wanted to increase infrastructure flexibility, agility, and scalability to be able to respond to business needs quickly. The biggest demand from our internal customer base was the ability to make changes to their compute environment and the underlying cost structure without having to make dramatic and fundamental forklift changes to the physical infrastructure.”

WaMu also wanted to improve server utilization across the enterprise. “Our average utilization was running at an average of 10 percent on about 9,000 distributed servers. We needed to drive that number up significantly. We also wanted to develop a faster deployment mode. Deployment times were typically in the 60-70 day range for any new physical asset from ordering to operational status.”

Working with VMware from the beginning, WaMu’s move to cloud computing progressed in four distinct phases over a three-year period:

1. Islands of compute: WaMu started in 2006 with 9,000 traditional, physical server deployments. This model was inflexible, underutilized and costly.

2. Compute pools: WaMu then moved to permanent allocations of virtual servers. This resulted in more flexibility, better utilization, and cost-effectiveness. But the company still had many virtual servers sitting idle and needed to plan for peak loads.

3. Dynamic compute: WaMu then shifted its focus to transient allocations of virtual servers. This created a highly flexible and highly cost-effective environment. Virtual machines were requested and allocated in 30-day increments. But there were still virtual servers sitting idle, and teams didn’t always need the compute for as long as a full month.

4. On-demand compute: In the final phase of its move to cloud computing, WaMu targeted allocations of compute on demand – self-service-based, highly automated deployments of user-defined and user-funded periods of compute time.

WaMu’s cloud computing program has dramatically reduced waste and complexity from its IT environment by allowing hardware and software to be leveraged more efficiently across the enterprise. Utility computing is now delivering scalable and on-demand computing platforms through the use of standardized building blocks coupled with the ability to allocate and provision services on-demand. Rationalization and simplification of WaMu’s infrastructure is reducing IT costs through elimination of redundant technologies – not just limited to hardware, but including all software, information and business services.

As a result of moving to the cloud computing model utilizing the VMware solution, WaMu has realized the following benefits:

- Virtual server footprint has grown to >1,500 servers.
- Utility compute is typically 40-70 percent more cost effective than equivalent physical servers.
- Unit costs for individual VMs have fallen 60 percent in 18 months.
- Deployment times for a virtual server are now less than five days.
- The cloud/utility program is fully self-funded and continues to grow.

When asked what advice he could give to other enterprises considering the move to a cloud computing environment, Warner recommended the following steps:
Step 1. Standardize and simplify all offerings

- Focus on building a repeatable set of building blocks.
- Target adoption for 80 percent of deployments.
- Develop easy to understand costing metrics.

Step 2. Use server consolidation to drive critical mass

- Use virtualization to consolidate workloads.
- Refresh all aging systems onto virtual platforms.
- Build trust with application development teams and business process owners.

Step 3. Automate and refine the offerings

- Deploy tools to drive transparency for platform users.
- Automate the deployment and lifecycle processes.
- Actively seek customer feedback and develop an advisory group to promote adoption.

“I see the difference between utility and cloud-based computing is that the enterprise cloud really focuses on true, on-demand compute,” explained Warner. “When somebody needs it, they get it. And if they need it for one day, they get it for just one day. Then they have the tools to destroy that workload at the end of the day or suspend it to disk, based on individual business parameters so they can provide that compute exactly when needed. That’s the most efficient model. And for WaMu, whether I do that within the four walls of my datacenter, or whether I use a third-party partner to do that is what cloud is all about. In the financial services industry, I see companies starting to focus on this model internally first – leveraging multiple datacenters and looking at how cloud enables the taking and using of excess capacity – but over time, this notion of a federated cloud is really quite viable because it enables this true on-demand footprint.”

Combining the Power of Internal and External Clouds at Marian College

Located in Indianapolis, Indiana, Marian College is a coeducational, Catholic college providing a liberal arts education to more than 2,100 students. The University was depending on antiquated hardware infrastructure and in need of a complete equipment refresh. The IT environment was not virtualized and there was no disaster recovery strategy in place. The college also had facility issues with its datacenter around capacity and power. The university’s IT management wanted the ability to understand variable costs, so as compute needs grew they could take a strategic approach to how they scaled.

After a careful evaluation of nearly a dozen different vendors and service providers, Marian College selected BlueLock a national provider of full-service cloud computing solutions. BlueLock provides its clients with the people, expertise, and IT infrastructure in world-class, SAS 70-certified data centers in Indianapolis, IN and Salt Lake City, UT. “Several other providers could offer a piece of the solution, but only BlueLock could meet all of our IT goals and still remain within our budget,” explained Mike Temaat, Network Engineer at Marian College.

“We engineered a solution for Marian College that we call the ‘BlueLock Box,’ using HP BladeSystem c3000s and a HP-LeftHand Networks iSCSI SAN,” explained John Qualls, CEO and president of BlueLock. “It is really just a turn-key internal cloud. It leverages compute, storage, replication, and VMware – the virtualization component – to meet all of the College’s IT goals.”

According to Qualls, the best way to understand it is to look at it from an external cloud standpoint. “This is the same approach as to how they use it internally,” he said. “We break the external cloud model down by communication (all of the bandwidth communication components); and then the security layer (router, firewall switch); the compute pool; the virtual images (which in the old days were servers); and finally, storage and backup. This enables Marian College to go to the business units and say, ‘you get three virtual machine images, and this much compute, and this much bandwidth, and this much storage,’ and charge service right back to the
individual business units. We provide them a template from the granularity standpoint to go and approach that.”

**Leveraging the VMware Internal Cloud to Move Data Seamlessly to an External Cloud**

“We were maxed out on storage, both hardware and physical space, making it impossible to back up our data any more,” stated Temaat. “We had tape and disk-to-disk backup on campus, but we wouldn’t have survived a major disaster. We needed remote replication, but could not afford to fund it as a standalone project.” By leveraging the design of the internal cloud and the fact that it connects seamlessly to the external cloud, Marian College gained the ability to simply ‘turn on’ the disaster recovery component to back up all data to one of BlueLock’s remote datacenters in either Indianapolis or Salt Lake City, Utah.

VMware has enabled Marian College to virtualize many of its critical servers and applications, including print servers, Windows Server 2008 and Windows Exchange 2007. The goal is to virtualize their entire production environment in phases. BlueLock provides external cloud services, enabling the College to backup its data cost effectively to a safe, off-campus location.

“We leveraged virtualization and the things that we did for the replication component to encapsulate the campus and move it to the external cloud,” explained Qualls of BlueLock. “We are able to provide disaster recovery to our customers at only 35-50 percent of the cost it would take to provision without the cloud. This is the real value of virtualization. VMware and the vCloud Initiative enable this kind of functionality.”

**Increased Storage Capacity, Reduced IT Infrastructure Costs, and Improved System Manageability**

The VMware and BlueLock solution enabled Marian College to consolidate 15 distributed servers in three locations to a single rack. “BlueLock and VMware have given us the ability to consolidate and virtualize our infrastructure, which reduces costs, improves utilization and enables us to establish cost-effective remote disaster recovery capabilities. It also reduces network latency because data is no longer distributed across different locations,” explained Temaat of Marian College.

The cloud infrastructure has also enhanced the end user experience for Marian college’s 3000 students and 450 faculty and staff members. “As a result of virtualization, our end-user experience has dramatically improved. Our environment is much more stable than before,” stated Temaat. “The virtualized environment is much easier to manage than the physical hardware. Having the flexibility to move from one blade to another with VMware vMotion™, take a blade down, restart storage, and update servers quickly and easily has been an amazing change. It enables us to increase productivity and keep things more up to date than ever before. The solution also increases uptime, adds more flexibility, and provides the ability to increase storage seamlessly,” stated Temaat.