

# Opportunities for the Cloud in the Enterprise

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PRODUCT STRATEGY





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# Executive Summary

## Challenge

Private and public clouds evolve the way IT services are delivered to the business. The promise of increased efficiency and agility of enterprise-class applications and services is intriguing, but enterprise customers are struggling with how cloud services can safely add realistic business value. The use of external cloud services challenge security and compliance, as well as service level management, which can involve multiple domains of control. Technology lock-in is an additional concern as various vendors deliver very different cloud computing offerings (and there are others of which you should be aware). The reality is that external cloud services are still working toward enterprise maturity.

## Opportunity

Pairing key cloud computing user scenarios with innovative IT management solutions will allow you to deliver agile and optimized IT services to employees and customers. You can decrease the time to develop and introduce new services, and meet the SLAs of current services during demand fluctuations. IT operations become simpler, capitalizing on resources that are managed in a highly efficient manner and delivered as part of an overall IT supply chain. You can continue to have seamless operational, performance, and security management of applications and services irrespective of where they are located and who manages them individually. In addition, IT can shift its focus towards innovation.

## Benefits

Intelligently embracing the cloud computing model will pave the way for you, as VPs and Directors of IT, to transform your infrastructure into an elastic business-responsive engine. By adopting this model internally as a first step, all of the benefits of cloud computing can be harnessed without concern. By further leveraging external cloud computing services, CAPEX spending shifts, in a reduced amount, to OPEX while management of the underlying physical resources shifts to service providers without sacrificing service quality. Cloud computing also supports Green IT goals through optimized resource consumption. In addition, you can better align business services with IT and business goals to enhance flexible business navigation through economic peaks and troughs.



## Cloud Computing — What Does It Really Mean?

Cloud computing is the evolution, over the past 15 years, of a continuing trend toward the industrialization of IT. This is in part due to the popularity of outsourcing and hosting of increasingly industrialized service definitions, cost structures, and pricing. The cloud computing model is enabled by the ongoing standardization of underlying technologies like virtualization, service-oriented architecture (SOA), and Web 2.0. This has spurred the dramatic growth in popularity and use of both the general Internet and corporate-wide intranets as trusted delivery models for business services. These technologies have made it possible to deliver IT services in a cost-effective and pervasive way. We see that this transition encompasses fundamental concepts such as just-in-time, pay-per-use, abstracted and simplified resources, federation, and composite applications and services. Customers are driving toward less cost, more availability and agility, as well as managed risk—all of which is accelerated by economic shock from the current global recession.

### Cloud Computing Defined

We believe the "cloud" is a metaphor for a network of computing resources accessible publically or privately over the Internet or an intranet. It is an abstraction of the complex infrastructure which is concealed from the end-user. The term "cloud computing", more specifically, represents a style of computing where dynamically scalable resources are provided as a service through internet technologies. These cloud services are typically offered within a pay-as-you-go business model, and service types can include: system and security infrastructure, application infrastructure, information, application, and business process. This model allows you to better consume services in the context of the business policy.

There are three common types of clouds: internal, external, and hybrid. An **internal cloud** is based upon a pool of shared resources (whether mainframe, distributed, or virtualized), whose access is limited within organizational boundaries. The resources are accessed over a private and secured intranet, and are all owned and controlled by the company's IT organization. In essence, the cloud computing business model is brought and managed in-house to enable shared IT services. An **external cloud** is a domain where the public Internet is used to obtain cloud services. The resources that make up those services are owned by the respective cloud service providers. Some examples include Salesforce.com, Google App Engine and Google search, Microsoft Azure, and Amazon's bevy of Web services such as EC2. A **hybrid cloud** is a combination of internal and external clouds, where services from each domain are consumed in an integrated fashion and include an extended relationship with the selected external service providers.

Access to any of these cloud computing services can be public (over the Internet) or private (over the public Internet or a private network, to a restricted group of consumers). We feel that "external cloud" and "internal cloud" supersede the more common "public cloud" and "private cloud" terms, as the latter do not well capture the combinations of physical resource locations and access rights.

Internal and external clouds serve as the backbone for a variety of different cloud computing service models. We can see that the industry has been successfully adopting three common types of cloud computing service models. **Infrastructure-as-a-Service (IaaS)**, sometimes



known as Hardware Infrastructure-as-a-Service (HlaaS), is a service model around servers (compute power), storage capacity, and network bandwidth. The offered resources most often leverage the agility and flexibility of virtualization, but can also be physical. Examples include Amazon (EC2 and S3), Rackspace, AT&T, and Verizon.

**Platform-as-a-Service (PaaS)** provides an externally managed platform for building and deploying applications and services. This model typically provides development tools (such as databases and development studios) for working with the supplied frameworks, as well as the infrastructure to host the built application. Examples include Force.com, Microsoft Azure, and Google App Engine. **Software-as-a-Service (SaaS)** involves applications or services which hide the supporting infrastructure from the consumer, but are able to scale to meet changing demands. Examples include Salesforce.com and NetSuite.

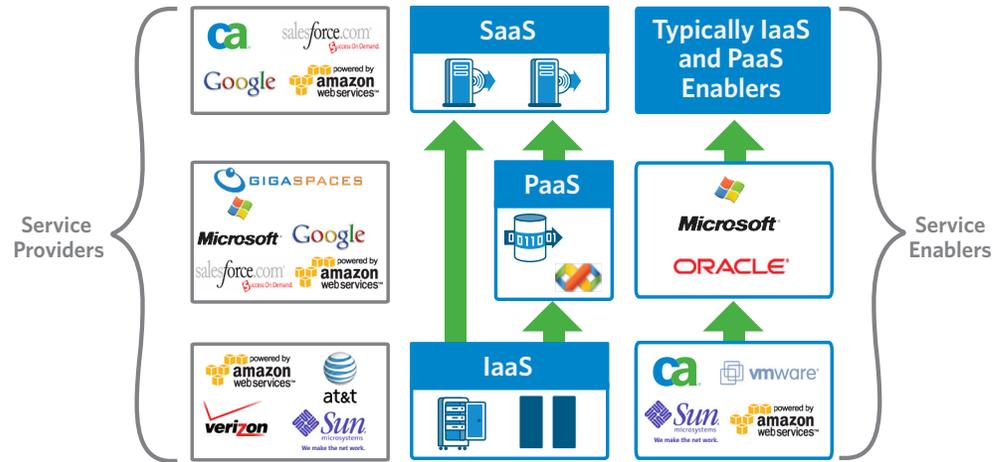
Cloud service enablers, or **cloud enablers**, help establish and maintain this particular business model. The technology that cloud enablers provide is also known as Software Infrastructure-as-a-Service (SlaaS). This can include technology that establishes the infrastructure (e.g. VMware, Citrix Systems, and 3Tera) or provides the necessary IT management capabilities (e.g. CA). Cloud enablers may also integrate the core offerings of multiple cloud service providers to provide composite applications and services. Cloud enablers are an important contributor to the adoption of cloud computing, as they strive to simplify and secure the use of multiple cloud services.

In addition to the **cloud service provider**, as a **cloud service consumer** you may also interact with a **cloud service procurer**. This person, organization, or entity obtains particular cloud services on your behalf. The cloud service procurer can negotiate better pricing and select the best cloud service(s) to meet your needs. The service procurer may remind you of a general contractor who outsources parts of a project to other companies or individuals while maintaining a direct relationship with the customer.

A special instance of the service procurer is the **cloud broker**. We define this role today as an organization or entity that creates and maintains relationships with multiple cloud service providers. This makes it possible for you to access services provided by multiple providers with a consistent user experience and minimal configuration. Cloud brokers provide additional services that are above and beyond those of a cloud service procurer. A cloud broker might provide consolidated billing, seamless switching between cloud computing services, or simultaneous connection to different cloud computing services, as well as federated identity management or other added services.

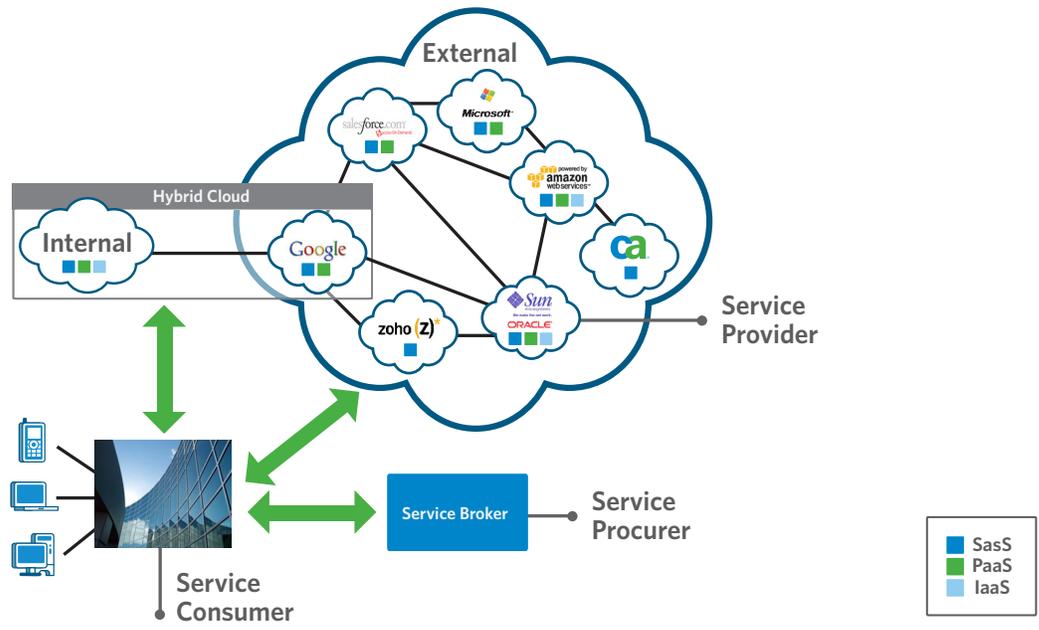
A cloud broker may also survey cloud service providers to understand their capabilities, liabilities, business models, and costs. This allows you to avoid multiple relationships in favor of forging just one relationship with a cloud broker who would understand your particular IT service requirements. The cloud broker could, in turn, select the best cloud services for the IT organization and monitor those services on its behalf. A cloud broker will provide you with significant cost savings and enable you to better use cloud computing to provide business value. We believe that the importance of this relationship will increase as your need to leverage multiple cloud services becomes reality. It is important to note that this is still an evolving role and may very well change in the near future.

**Figure 1**  
Cloud Service Models  
Working Together



**The Evolution of Enterprise IT**

**Figure 2**  
Enterprise IT Infrastructure  
Becomes a Supply Chain,  
Consisting of Internal and  
External IaaS, PaaS, and  
SaaS Providers





According to IDC, by 2013, customer spending on IT cloud services will more than double to \$44.2 billion from 2009.<sup>1</sup> Cloud computing will have a profound effect on your IT infrastructure, as depicted in Figure 2. This can become the result of implementing an internal cloud or through use of external cloud computing services, or both. IT infrastructure is evolving into a service supply chain, comprised of multiple service domains integrated to better support business service goals. So the relationships between cloud service providers, both internal and external, will become important to your business.

In our view, the cloud computing model brings together four dimensions of complexity:

- Applications and services will further evolve from being monolithic and static toward composite and dynamic. This in turn increases the reliance on network performance as well as the separation from the traditional data center.
- IT infrastructure will continue to shift from physical to virtual dependence, complicating IT orchestration with more moving parts.
- Operational domains of control will move from single to dual toward multiple, which isolates operational decisions from management-based policy and complicates SLA and performance management.
- Business models move from per-instance licensing to pay-as-you-go licensing, which will require better project financial management and exploration into chargeback methods.

These evolving characteristics of dynamic applications, virtual IT infrastructure, multiple operational domains of control, and pay-as-you-go business models are in fact the common characteristics of cloud computing environments. Inherently, there is more to cloud services than just IT resources consumed on-demand. The concerns in adopting the cloud computing model generally fall into four categories: security and compliance, performance and reliability, loss of control, and production transition.

### **Security and Compliance**

There are clear concerns around identity and the security of information transfer and retention. Various regulations such as Sarbanes Oxley and HIPAA drive the need to be extremely cautious with data, with serious legal ramifications in the event that data is compromised. Some countries also have strict guidelines around the export/transfer of data outside country boundaries. As the notion of an identity crosses multiple domains, the access rights need to always be consistent and single sign-on has to be enabled. Many companies and government agencies are also uncomfortable with their data being located on hardware outside of their direct control, including geographical boundaries. This unease quickly turns to fear when you add the fact that cloud computing services are inherently multi-tenant, meaning that other companies, even competitors, are sharing the same hardware resources. Trust, managing risk, and privacy become paramount within the IT landscape of cloud computing.



### Performance and Reliability

The enterprise immaturity of most cloud service providers is another significant concern. While a service level agreement (SLA) can be structured to meet the demands of various businesses, there is always a small margin for error. Internal IT departments are often judged by the uptime of their most important applications. Cloud service providers like Amazon and Google offer guarantees of 99.9 percent uptime, likely significantly higher than internal teams can manage for most applications. But many IT organizations worry about the health of their applications in the event of an outage or performance degradation with one of those providers. This issue is compounded by the fact that cloud service providers make no guarantee on the uptime of a company's external Internet connection, which if down would shut off all access to those resources. Today, mission critical applications that require very high performance are unlikely to be deployed in the external cloud.

### Loss of Control

One of the biggest benefits of cloud computing is the reduced cost of running and maintaining your internal IT infrastructure. Entrenched IT departments and CIOs, however, may be reluctant to cut their importance and budgets by outsourcing the bulk of their company's IT applications and infrastructure to a cloud service provider. Companies are hesitant to push mission critical applications and data such as ERP and even email to an external enterprise over which they have much less control. Any trouble with the cloud service provider (e.g. bankruptcy) could mean significant risk to the consumer's business. And even though the risk with companies like Google and Microsoft are low, enterprises may still fear becoming too dependent upon even these large and stable cloud service providers. Organizational inertia and cultural impact have often proved to be far greater barriers to adopting new technologies than technological feasibility.

There is another challenge around a cloud application's flexibility. The traditional software model has allowed enterprises to deploy customized business applications to account for business specifics. Cloud applications, at least currently, do not allow nearly the same level of customization. The intellectual property is external to the consumer's company and the application is shared with multiple tenants. This limits the types of applications that can be based solely on external cloud services. Proprietary application development environments may also hinder the ability to bring cloud applications back "in-house," and can create "lock-in" to a particular cloud service provider.

### Production Transition

How do you transition your production environment, either in part or whole, to the cloud? It is a critical question to answer, and the migration has to be a reliable and efficient process that does not interrupt the business. Some elements of the process include:

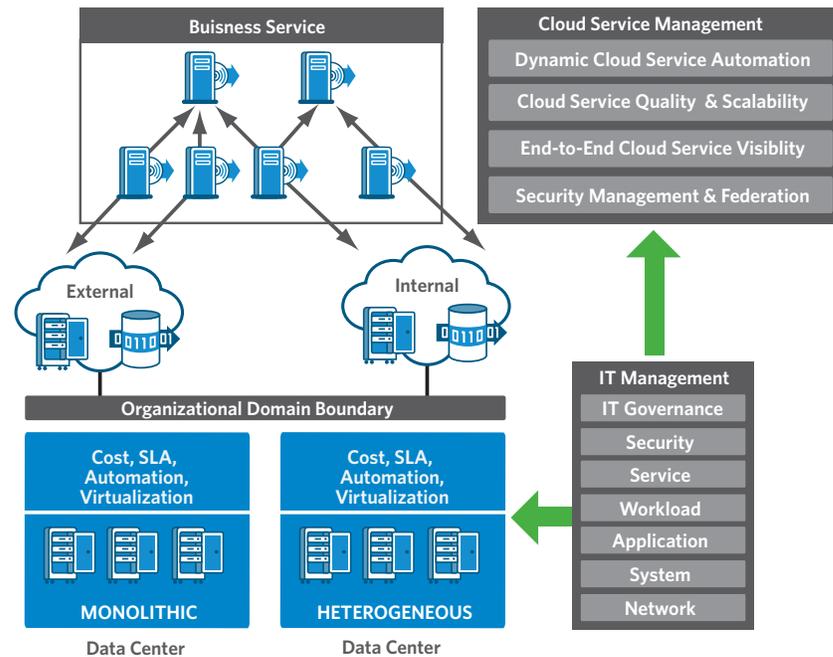
- Capturing both the state and data for applications and servers
- Storage and retention of this information to enable recovery if necessary
- The actual movement of applications and servers, potentially in real time
- Recovery and reconstitution of state and data for applications and servers, to both physical and virtual environments



This all needs to be invisible to your users, with no loss of availability. The type of cloud environment should not matter. Applications and systems should move together with their data and state information. This process should be reversible in the event that the transition is not successful.

### Reduce the Bottleneck on IT Resource Delivery

**Figure 3**  
The Cloud Evolves  
the Business Service  
and Transforms IT  
Management Solutions



In the past, the underpinning of a business service was limited to IT resources that were wholly owned by the provider of that service. This invited silo-based approaches to management of services in areas such as system, network, security, and IT governance. But with cloud computing, the business service architecture will cross the organizational boundary and become a composition of various attributes which are separately managed within different domains. It will not be enough for traditional IT management solutions to simply extend capabilities into this model. As illustrated in Figure 3, we believe that IT management has to view the business service from the top-down, and provide capabilities in the following key areas.

- **DYNAMIC CLOUD SERVICE AUTOMATION:** Automate control, update, and movement within the heterogeneous, multi-location IT infrastructure supporting your applications and data. This results in a more flexible environment which can support variable, up-to-the-minute business requirements, with an eye toward maintaining SLAs.
- **CLOUD SERVICE QUALITY AND SCALABILITY:** Manage a composite transaction end-to-end, from the end-user's perspective through to the visible infrastructure. This assures that cloud service performance and availability meet expectations.



- **END-TO-END CLOUD SERVICE VISIBILITY:** Visibility into the components of a composite application which may reside in multiple organizational domains. This will optimize your resource management and utilization, streamline IT processes, and reduce costs.
- **SECURITY MANAGEMENT AND FEDERATION:** Manage the security and compliance of identities and information as they flow between organizational domains. This will unify identity and centralize policy access and control.

The new business service still needs to leverage key management capabilities that have been prevalent for years. But the services delivery model for some of these management capabilities will be required to adapt to the business service's dynamic multi-domain nature.

As the delivery of IT and business services becomes more and more like a supply chain, IT management becomes ever so important to enable these interconnections across organizational boundaries. The mobility of IT assets and related data between internal and external infrastructures, as well as between service providers, must be enabled and managed. This must all happen without sacrificing the governance, management, and security essentials that enterprises have grown to depend upon. The growing use of SaaS applications for non-strategic business use (such as email, project and portfolio management, etc.) is an example of this movement. We believe that this gradual maturity will be further defined by certain key customer scenarios.

### **The Internal Cloud**

Given the performance and economic attractiveness of external clouds, it is logical for you to ask if there is a way to take advantage of all of those benefits and somehow get around the challenges. One approach, and certainly a recommended first step toward cloud computing, would be to construct a cloud-like architecture within your organization's own data center. Clearly, if a commercial hosting entity is able to develop such a platform, then the same ought to be possible to create an "internal cloud" with equivalent performance and economics within your enterprise's walls.

Fortunately, solutions and technologies are available today that can help remodel your existing, heterogeneous data centers to function as an internal cloud. The high-level expectation is that any internal cloud architecture should not adversely impact existing assets and processes. We believe that some of the requirements for this type of internal architecture include:

- Managing existing heterogeneous compute, storage, and networking platforms (including multiple revisions, updates, and patch levels per platform)
- Managing multiple, heterogeneous virtualization platforms
- Providing service-centric features (design, measure, and maintain a catalog of services, chargeback, etc)
- Not disrupting security processes and procedures, existing application architectures, and existing application code bases or configurations
- Being compatible with existing configuration management processes
- Being compatible with existing tracking, logging, and compliance systems
- Providing per-use resource cost metrics and usage metrics



With these operational requirements, an internal cloud will generate the same capacity “elasticity”, economies-of-scale, failure-tolerance, and cost transparency of an external cloud. Essentially, the only difference is that the cloud is behind your firewall, within your facility, and under your control. Most compelling of all, it can use your existing resources and support your existing applications.

You will need IT management solutions to evolve your IT infrastructure into an internal cloud while managing your existing IT infrastructure. This includes taking advantage of cloud-specific features such as fast provisioning and resource self-service. Efficient and automated management of virtualization, proper workload distribution, and provisioning on demand are just a few of the capabilities that these solutions can provide. We envision the growth of multiple internal clouds arising around particular business functions (e.g. finance), thus furthering the necessity of a solid management solution across these internal domains of control. We believe that the adoption of an internal cloud model is a necessary first step toward intelligent use of external cloud services and establishing a hybrid cloud.

It is important to note that creating an internal cloud is not only predicated on distributed hardware. The mainframe can also be used as your platform of choice to dramatically lower cost and achieve competitive advantage. Well-managed mainframes have up to a 96 percent advantage in terms of energy usage and are the gold-standard in terms of reliability, scalability, and virtualization. Despite the changing workforce leading to a “skills shortage” for hardcore mainframe knowledge, “Mainframe 2.0” solutions are penetrating the market in way that hides the intricacies without losing control or dramatically changing the way mainframes are utilized. As such, we can also foresee the mainframe becoming an important platform for cloud computing.

There are still a few differences between building an internal cloud versus using an external cloud service provider. Primarily, with an internal cloud, a data center’s resource capacity is limited, and billing goes to an internal “vendor” (possibly the central IT organization) rather than an external entity. The existing cost of internal capital or operation of that capital is not lowered. However, the total available capacity, total used capacity, and associated cost metrics are highly monitored and controlled. Tracking real-time global capacity usage (rather than per-application usage) is greatly simplified, allowing your IT operations to more easily forecast new capacity and capital additions. Finally, in the process you become closer to becoming a provider of IT services for your business (an internal cloud service provider).

### **Cloud Bursting**

Cloud bursting is the ability to leverage external cloud services on a short-term, as-needed basis. This is a way for you to extend your existing internal IT infrastructure or your internal cloud. For example, if you require additional compute capacity relatively quickly and for a short period of time, you could lease the required capacity from a cloud service provider and end your agreement when this need subsided. This would be typically useful around seasonal or event-based peaks of traffic that push your existing IT infrastructure over its capacity, but is not consistent enough to warrant additional hardware and software investment which would for the most part sit idle. The resources are acquired from the cloud service provider, secured, provisioned, and added to load balancers so that they then have the ability to take on the additional requests. This can happen on an approved, scheduled, or as-needed basis.



There are solutions that exist today to extend your IT into the cloud. We believe that a “mediation layer” will be required, which would have the ability to understand what resources are available both internally and externally. Then, based upon predetermined business policies, the dynamic reconfiguration of the internal and external computing infrastructure would be automated to provide an optimum level of service. You will have to extend your security levels to the information that is located on external cloud resources as well as the identity of the roles that are used to access that information. These security measures must become part of your provisioning processes and not be an afterthought. To guarantee customer SLAs, you need the ability to manage the performance of an application or service that spreads across internal and external resources. If there is a problem and it is pinpointed to an external cloud resource, the appropriate measures must be taken to repair the problem based upon your relationship with the cloud service provider. Eventually, you will also want to ensure that the use of these services are accounted for and charged back to the right departments within your organization.

### **Disaster Recovery in the Cloud**

Leveraging an internal or external cloud can optimize your disaster recovery procedures. This model eliminates duplicate dedicated servers as back-ups or the use of high-priced, outsourced services that promise to get you back online within a certain time frame, at least for some types of applications. Outsourcing your off-site disaster recovery procedures reduces the high cost of maintaining stand-by sites. Remember that implementing virtualization alone does not guarantee that the virtual servers become part of disaster recovery plans. Cloud-based backup services can ensure that VMs are included in the mix, by taking an application-centric view to disaster recovery. And connections between cloud service providers can enable data replication between providers.

Management solutions will help you use these external cloud services and integrate them with your existing backup and disaster recovery procedures. These solutions have to take advantage of technologies such as volume-level snapshots and imaging. Data deduplication will also become important, due to contention between the amount of data that you have to move and the pipes that you have to move them. Integration with identity and access management solutions will ensure that access to the data which lives outside your organizational walls is secure. In the event that you need to transition away from a cloud service, these solutions will enable you to properly migrate applications and data back internally or over to another cloud service while assuring service availability.

### **Building and Testing in the Cloud**

Current cloud services are ideal for getting your feet wet through development and testing projects. They allow for quick procurement of the necessary resources, from the infrastructure through to the development stack and tools. When completed, your built applications or services can be hosted by the cloud service provider or brought back in-house for further use. The biggest problem with this scenario is bringing your application or service back in-house or transferring it to another cloud service provider. This is because the development infrastructure is not consistent across cloud service providers and is proprietary. We believe that solutions will be required to help provide common access points for developed applications or services, or



provide a mechanism to relocate your cloud applications to an internal or another cloud service provider's infrastructure. Note that for short-term, independent projects this may not be a problem (e.g. testing applications on leased platforms during the development cycle).

### Leveraging Best-of-Breed Cloud Services

Once you have established an internal cloud, and you have gained a level of confidence in the use of external cloud services, the next logical step is to set up a hybrid cloud. It is important to have the right management solutions in place to ensure that you keep track of the external resources used and satisfy financial agreements that have been established with cloud service providers. Management solutions must ensure that any change management updates are propagated to external resources; this includes identity and policy updates. In the hybrid cloud model, IT assets and data will move between on-premise, near-premise, and off-premise locations. IT management solutions must manage these locations centrally, and ensure that IT assets and data are properly moved, activated, and protected. The goal is to treat the hybrid cloud as if it were one large pool of resources, unknown to the user that there are actually vendor-owned resources underneath.

As the choices for and use of IaaS, PaaS, and SaaS services increase, so will the need for managing the relationships between the different providers. A cloud broker, as we see the role today, would be ideal so that you as a consumer will have only one relationship to maintain. This role would be invaluable in providing to you an integrated service based upon your explicit needs. The cloud broker may very well provide the necessary requirement for simplifying, optimizing, and maximizing your use of cloud-based services.

### Start the Journey Toward Elastic IT

An internal cloud dramatically increases the efficiency of your existing IT assets. This in turn allows for an agile environment that can better adjust to business changes. The faster time-to-value enables quicker implementation of new initiatives. And you can provide support for Green IT goals through physical footprint reduction and the throttling of power-hungry compute and storage resources.

Your use of external cloud services eliminates the significant up-front expenses required to purchase and maintain hardware. As a cloud service consumer, you pay for only the capacity that is used and can easily scale up capacity without the need for additional capital expenditures. This enables just-in-time use—as opposed to spend that supports having a high watermark of resources online all of the time. Your costs shift from fixed CAPEX to variable OPEX and better align to your evolving business needs and drivers. If your business is just beginning, the use of external cloud services allows you to establish IT operations quicker with less of a requirement for internal IT expertise.

With the right management solutions, you have the opportunity to address the challenges of cloud computing. This allows for significant benefits from both an IT and business perspective. And it enables you to take a supply-chain approach to IT, leveraging best-of-breed solutions as links in the chain supporting your initiatives.



## Conclusions

Cloud computing represents the next evolutionary step toward elastic IT. It will transform the way your IT infrastructure is constituted and managed, through consumable services for infrastructure, platform, and applications. This will convert your IT infrastructure from a “factory” into a “supply chain”.

There are a number of concerns with adopting this model, most notably around maturity levels, security and compliance, performance and reliability, relinquishing control of IT assets outside of organizational walls, and transition of production environments. IT assets, and their associated data, will also become much more mobile. As applications become more dynamic and composite, infrastructure becomes virtualized, operational domains of control become multiple, and pay-as-you-go becomes prolific, the business service becomes more about relationships and less about technology. Next-generation management solutions will be required to allay such concerns and address the specific management needs of the cloud-connected enterprise.

If you have an established internal IT infrastructure, implementing an internal cloud will provide some of the promised economic and agility benefits of cloud computing. This approach will provide your enterprise business with a number of valuable future IT options which might otherwise have been unavailable. It is also a good first step before you begin adopting external cloud services from different cloud service providers. It is important to think about the user scenarios most important to your business before jumping to cloud service providers. It is also important to have a plan in place to transition away from these service providers should the need arise. Look toward experienced IT management solution providers to help manage both the existing IT infrastructure and one that is organized around a cloud computing architecture, as the tenets of governance, management, and security take on an even greater importance.

The end goal is to reduce cost, increase business agility and flexibility, and manage risk. We do not believe that you can do this manually, or by using a silo-based approach. It has to be a highly automated end-to-end approach. This involves understanding all of the available resources (servers, storage, networks, applications, etc.) and their users, the state of those resources, the relationships between them, the constraints on them, and their dependencies. This has to be done in near real time, in a way that provides feedback from the user experience to the infrastructure automation layer and back again. In short, it needs to be a globally optimized, closed-loop automated process for the entire system. Getting the maximum value out of internal and external clouds demands this closed loop approach.

Cloud computing provides tremendous potential for optimizing IT services to your business. However, it is important for you to seek next-generation management solutions that can aid in the proper adoption and expanded use of the cloud computing model.



## References

<sup>1</sup>IDC eXchange, IDC's New IT Cloud Services Forecast: 2009 - 2013, <http://blogs.idc.com/ie/?p=543>, October 5, 2009

## About the Author

**Sam Somashekar** is an Advisor of Product Management at CA, Inc. Sam has over 15 years of experience demonstrating success in enterprise software product management and development, business development, strategy, marketing, and market research. He has experience establishing, developing, and inspiring high-performance teams, providing product vision, and delivering the best value to customers. Sam's current responsibilities include defining CA's Enterprise IT Management strategy and vision around key technology trends such as Green IT and Cloud Computing.

Sam holds a BA in Computer Science and Biology from New York University, and is PMC certified in Product Management. He is also on the board of AFCOM's Data Center Institute, and has authored several articles and whitepapers on the subject of enterprise IT management for publications such as CA Advisor and Smart Enterprise Magazine. Sam has also been quoted in articles appearing in leading industry publications such as InfoWorld and Computerworld.



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