Joyent

Cloud Computing: an Overview

A Joyent White Paper

Executive Summary

An increasing number of businesses are discovering that cloud computing can save them significant operating and capital expenses. However, cost is not the only reason companies are moving to cloud computing. This paper examines the many strategic business benefits behind the adoption of cloud computing in small, medium-sized, and enterprise companies. As with many new technologies proposed for improving business processes, customers have legitimate questions about adapting their critical applications and data to these technologies. Similarly, myths and misperceptions of new technologies may easily spread with little basis or justification. This paper addresses potential business concerns and prevalent misperceptions of cloud computing and offers interested businesses concrete advice for making informed decisions. Finally, this paper broadly describes the cloud computing architecture that Joyent offers, including the company's unique approach to pricing, flexibility, performance, and business resilience.

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Introduction

Cloud computing can dramatically lower the cost and complexity of computing for large and small businesses. However, before choosing a cloud computing solution, businesses should have a more thorough understanding of cloud computing capabilities—and limitations.

Perhaps the best way to begin to appreciate the potential for cloud computing is through a concise definition of the term:

> *"Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction." – The National Institute of Standards and Technology, U.S. Department of Commerce; October, 2009.*[1]

The delivery of computing resources *on-demand* is key to the core concept and value of cloud computing. Until recently, customers who relied on computing resources needed to buy, install, and maintain their computer equipment and software, regardless of the type of computing they needed to accomplish. This is still the prevailing model for data processing and networking at most businesses around the world today. Under this "wholly owned" computing paradigm, whether an application is used every minute of the work day by thousands of employees or merely once a year by one user, the company must purchase, maintain, and provide the infrastructure for accessing that computing asset. The idea of allowing on-demand access to configurable resources has tremendous cost-benefit advantages, as this paper examines in more detail later.

Cloud computing could not have become a viable business market offering, however, until the second half of the cloud computing definition became a reality:

> *"…a shared pool of resources that can be rapidly provisioned and released with minimal management effort or service provider interaction."*

Rapid provisioning of shared resources evolved out of the adoption of Internet computing. As ecommerce and Internet businesses ramped up in the late 1990s, success depended on serving a large number of online customers and processing thousands of transactions and hundreds of applications simultaneously. To handle this type of workload online, Internet companies developed more dynamic computing infrastructures and software applications.

These online tools rapidly evolved into sophisticated systems and ultimately served as the basis for cloud computing. Where these online architectures and applications first served only ecommerce business developers, next-generation infrastructures and applications can now be dynamically allocated to any member of the Internet network community. In essence, what was learned, tried, and tested through the rigors of successful online commerce, can now be offered as a computer service end-product to the wider business community.

The second key component in the evolution of cloud computing was virtualization of computing resources. (Virtualization is the creation of a virtual version of a resource—such as a server, a disk, or CPU—inside a computing framework.) A large physical server, for example, could "run" multiple copies of virtual servers, each with their own virtual memory, CPU and disk. Therefore, this pool of virtual resources can be more rapidly provisioned and deployed over the Internet than any physical resource.

Today, dozens of companies offer cloud computing products of varying sophistication and capabilities. As a testament to the features and business benefits of cloud computing, this diverse market segment has grown tremendously over the last three years. According to industry

analysts at Gartner Group, Inc., revenue for cloud computing totaled $56.3 billion in 2009, a 21.3 percent increase from the industry's 2008 revenue of $46.4 billion. Gartner further predicts that market revenue for cloud computing will exceed $150 billion by 2013.[2]

While much of the growth in cloud applications and infrastructure is driven by cost-conscious enterprise businesses, the cloud computing industry is increasingly developing products specifically for mid-sized and small businesses. The goal is to exploit the unique advantages of cloud computing to give their businesses a competitive edge. Even the smallest business can realize immediate reductions in capital expenditures for application software, for example. In fact, some industry analysts, such as Cambridge, Massachusetts-based Forrester Research, explicitly advise large and small customers to adopt cloud computing as a cost-savings strategy during the current economic downturn.[3]

Although trimming costs is one advantage to cloud computing, it is not the only motivation for adopting an on-demand, configurable pool of computing resources. Cloud computing can save maintenance and downtime, reduce human capital required to manage a data center, and can better accommodate business growth.

The Business Case for Cloud Computing

The primary motivation for businesses to move to cloud computing is to save money. Specifically, companies will spend less on computer hardware and software, reduce the number of personnel required to maintain their data, and significantly save on the space and energy needed to run their computer equipment. However, cloud computing also arms companies with cutting-edge tools to become more competitive, including flexible and agile computing platforms, more scalable and high-performance resources, and highly reliable and resilient applications and data.

Flexibility, Scalability, and Resilience Using Cloud Computing

While cost savings may be the prime motivation for moving corporate resources to a cloud computing platform, companies are discovering that cloud computing also offers business advantages that are difficult to realize in any other fashion. Because of the ease with which new resources can be added when using cloud technologies, companies can respond quickly to unexpected increases in demand rather than wait for infrastructure upgrades—a wait that could cause lost business and create lasting damage to the perceived value of a service. Similarly, businesses can throttle back their consumption of computing resources during off-peak hours or during slower business seasons, rather than paying for capacity they will not use. This rapid, elastic response to business requirements through cloud computing gives businesses a competitive advantage in the marketplace over companies clinging to a fixed computing asset model.

Similarly, companies using a cloud infrastructure can develop and deploy new applications in a fraction of the time required in more traditional computing environments. Testing and development resources can be quickly allocated and isolated from production processes, and can just as easily be removed when they are no longer required. Development can be conducted safely and under nearly identical environments as final production deployments, insuring more reliable and predictable application performance. Therefore, cloud computing delivers scalable and high-performance capabilities on-demand without significantly increasing operating expenses or capital outlays.

Finally, companies that deploy applications on high-performance cloud computing platforms are guaranteed a level of business continuity and resilience nearly impossible to duplicate on owned computing systems without a significant investment in disaster recovery sites, replication software, and highly trained disaster recovery and storage management

personnel. Because sophisticated cloud computing platforms keep redundant copies of client data at multiple cloud computing data centers, customers are protected from local physical disasters such as fire and flood, accidental data loss or corruption, and malicious data destruction. If data or applications become unavailable at one site, systems can switch over to the backup data center.

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Hardware, Software, and Maintenance Savings

Computer hardware such as CPU, disk, memory, and network I/O is notoriously under-utilized in business data centers. Typical server utilization, for example, may be from 15 to 30 percent of capacity on average, with only intermittent spikes of activity pushing the server environment to approach its full capacity. In a recent study, one accounting firm found typical server utilization rates as low as 12 percent. In stark economic terms, this means that roughly $4400 of every $5000 server investment is idle. As a result of all these factors, business data centers are wasting a huge percentage of their hardware money.

In an ideal cloud computing environment, companies would pay only for the hardware resources they use, when they use them. In addition, the cloud platform should easily adapt to the customer's business profile, seamlessly adding more resources during peak computing periods or during unexpected spikes in activity.

While tracking the initial expense of buying and installing network applications such as email, SQL, or other productivity software at a typical business is easy, the true cost of ongoing maintenance and support of that software is often hidden and poorly understood by many companies. Upgrades, data backup, configuration, and technical

support multiply the true cost of software well beyond the original purchase price. Support and productivity losses such as downtime during upgrades or recovery of lost data are rarely figured into the bottom line cost of software, yet are significant cost multipliers. Delivery and configuration of software can be significantly streamlined under cloud computing, and the reliability of cloud computing data centers ensure that downtime and data loss are minimized.

Hidden Personnel Costs

According to a recent study published by *Government Computing News*, companies could potentially save 70 percent of their operational costs using a cloud computing provider versus managing the same resources in house.[5] A significant portion of these operating expenses are related to IT personnel. For example, a typical network administrator's yearly salary is $69,000, while network security specialists cost on average $87,000 per year.[6] Most mid-sized networks require dozens of IT professionals and technicians to maintain operations. But salary and benefits are just one component of IT personnel costs. Ongoing training of personnel is also essential for maintaining a high level of expertise among IT employees that require time off for retraining, potential travel to IT seminars and workshops, and tuition and fees associated with continuing education. Other personnel expenses include auditing for compliance with government regulations, such as HIPPA and Sarbanes-Oxley.

Cloud computing significantly reduces the number of IT personnel at a business by shifting maintenance, IT expertise, and many compliance requirements to the cloud infrastructure provider. In fact, depending on the competency of the cloud computing provider, most companies will receive support and expertise that far exceeds what they could possibly afford to recruit on their own.

Energy and Space Savings

With fewer servers, storage sub-systems, and network routers on the premises, companies that move a significant portion of their computing infrastructure to a cloud provider save money on both the electricity to power those systems and the air conditioning systems required to keep them cool. Floor and rack space for equipment is also reduced. Because the most sophisticated cloud computing data centers are more energy efficient, this energy savings is not just shifted to the cloud provider but constitutes actual savings and a net reduction in total energy consumption, resulting in a positive impact on the environment.

Cloud Computing Concerns

While the business benefits of cloud computing are clear, some businesses are still reluctant to move critical data and applications to cloud computing, and especially to a third-party cloud infrastructure. Some common concerns include the following.

Lack of direct control. With data hosted by a cloud provider and not on the company's premises, management may feel that data is no longer under the direct control of the business and somehow more vulnerable. However, once business managers and IT directors are familiar with the management tools and data structures of the cloud-based applications, many of these control issues can be dismissed. The cloud provider should give the customer tools for data management, and the provider should have ample disaster recovery and fault tolerant measures in place to protect the data 24X7.

Uncertain security. Once customers become familiar with the security procedures and measures that most cloud computing providers have deployed, they find there is little concern about security. In fact, depending on the cloud provider, customer data in most cases is far safer at a cloud computing facility than on typical network LANs, where

decentralized security management can introduce any number of ongoing security vulnerabilities.

Utility pricing. Unpredictable pricing is a frequent concern of many companies considering cloud computing. Because many cloud providers operate on a utility pricing model, customers are charged by usage—similar to cell phone or electricity use. Therefore, many companies are concerned about the potential for wildly fluctuating computing costs. However, not all cloud computing providers use utility pricing, but instead offer fixed price plans, keeping computing costs predictable and affordable.

Data lock-in. Many companies fear that once they commit to cloud computing, their data and businesses are locked in, making them ”hostage” to a particular provider of cloud services. For this reason, companies should ensure that any hosted applications or services they use are based on open standards and open data formats in the event that they need to quickly and cleanly migrate their resources to another vendor or system.

Supplier viability and reliability. Customers should be concerned about the viability of any IT supplier, especially one tasked with hosting critical applications and data. For this reason, potential cloud customers should check not only the viability of the host’s infrastructure but also check its financial health and market standing. Aside from the cloud provider’s long-term market viability, what measures do they take to ensure their data centers are reliable and available 24X7?

Cost of converting to cloud computing. Many customers are understandably concerned about the cost of converting from their current applications to cloud-based applications. In many cases, such as SQL databases, spreadsheets, and word processing documents, the cost will be nominal as cloud-based applications can preserve the formats most businesses are currently using. Custom applications may

require more time and expense to convert, however. For these reasons, many companies moving to cloud computing often do so incrementally. They may first offload their email, word processing, or data storage tasks to offsite cloud computing resources on a trial basis before committing larger aspects of their business infrastructure to a new platform. A recent study found that 70 percent of companies that utilized cloud computing on an incremental or test basis planned to further deploy cloud computing more broadly.[7] However, other companies find that just one or two applications delivered on cloud computing can make a big difference in their bottom line and productivity, and may never see a need to move any other data or applications to a cloud provider.

Myths and Misperceptions about Cloud Computing

Cloud computing, like many new products, is subject to misperceptions and myths. These myths probably arise primarily from a poor understanding of the technology or the capabilities of the providers.

Myth: Cloud security and compliance is impossible to achieve. Cloud computing security is no different than any heavily secured ecommerce or wide area network. To be sure, not all cloud computing vendors utilize the same technology measures, and for that reason it is up to the customer to thoroughly scrutinize the cloud provider's security; however, cloud computing in itself does not introduce any new or unforeseen vulnerabilities or weaknesses. Also, cloud computing companies can provide a unified platform for conducting and verifying compliance audits.

Myth: All clouds scale on demand. Not all cloud vendors have the resources or architecture to adequately scale applications and traffic on demand. While all try to maintain a certain number of extra resources to accommodate fluctuations, many cannot dynamically scale operations when demands exceed predicted thresholds. For example, in most

cloud computing environments, scaling to add more users (horizontal scaling), requires manual reconfiguration and allocation of additional CPU resources. As a result, companies should carefully select their cloud computing provider to ensure it can dynamically accommodate increased user demand; otherwise applications and users may be subject to frequent and disruptive slow-downs and system bottlenecks.

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Myth: Virtualization = cloud computing. Virtualization makes dynamic, scalable cloud computing possible, but does not constitute a cloud architecture on its own. Virtual machines deployed without intelligence or dynamic scalability can be nearly as inefficient and costly as physical resources they replace. In fact, many enterprises have identified this inefficient use of virtualization and dubbed it "virtual sprawl." This unchecked proliferation of virtualization, in turn, can easily translate into a decrease in network performance according to a 2008 report by the Aberdeen Group.[9]

Myth: Performance is worse in the cloud. If the cloud infrastructure and applications are poorly managed and deployed, this might be true. But when properly configured, most users notice no difference when using cloud-based applications. In some cases, cloud computing provides noticeable improvements in performance as better provisioned machines with access to more resources can better handle more complex processes than poor-performing, local desktop computers. The most significant potential bottleneck for cloud computing is access

to the network itself. If users are connecting over high-speed connections, performance should never be an issue.

Myth: The cloud requires more IT management. In the beginning of a deployment, as users and applications are carefully migrated to cloud infrastructure, this may be true. But once conversion is completed, local IT no longer must manage the software, the hardware, or the data protection of the applications and associated data. In fact, every application migrated to a cloud infrastructure cuts maintenance costs and management overhead.

Myth: Cloud computing is only good for low end applications and software as a service. Many vendors have jumped into the cloud computing marketplace with simple software applications and declared themselves "cloud computing" experts. While their applications may certainly fill a need, delivering a simple application over the Internet does not approach the sophistication or complexity of delivering massive computing infrastructures on demand. Cloud computing is the backbone on which businesses worldwide perform thousands of transactions a second, transfer massive amounts of data across the globe, and securely process trillions of dollars of financial transactions. The most robust, secure, and scalable business applications available today operate using cloud computing.

Myth: Cloud computing is less reliable than in-house systems. Some of the most secure and reliable installations in the industry are cloud computing data centers. The best cloud computing centers are built from the ground up with multiple layers of redundant components, power, physical and cyber security measures, and staffed by highly trained personnel. Using an economy of scale impossible to duplicate except at the largest enterprise IT centers, the best cloud computing centers deploy reliability, security, and failsafe measures that most businesses simply cannot afford.

Joyent's View of Cloud Computing

Business computing is constantly evolving as business needs change and technology advances. The first great wave of business computing was centrally managed. This mainframe-centric world meant that all data was kept, processed, and managed from one central location. Users could access and enter data, but only through strict central control. This central control caused problems with productivity as users struggled for adequate access to produce and share timely work.

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With the advent of PC and LAN computing, data and computing resources became decentralized, spread across numerous servers, and on individual desktops spread throughout the business. Now data was easier to access, productivity increased, yet the chaotic dispersal of data caused problems with security, data reliability, and wasted computing resources. Finding and retrieving data in a decentralized system is often difficult as well, causing numerous inefficiencies. Similarly, computing resources increased dramatically, but they were not easily accessible throughout the network.

With a distributed computing architecture based on cloud architecture, users are looking for the security, protections, and reliabilities of the centralized mainframe computing systems combined with the access and connectivity of a decentralized LAN environment. Joyent's smart computing software enables a complex network of data centers to work together as a unified computing platform on which companies can build their next-generation applications.

The Joyent Approach to Cloud Computing

Many cloud computing vendors provide hardware-like virtualization, thereby satisfying the requirement to call their products “cloud computing.” Joyent’s approach uses the cloud computing tenets of resource pooling and on-demand infrastructure to make creation and delivery of applications easier and more successful. Joyent has built three layers of Smart Technologies that can be used independently to achieve lower costs, greater performance, and increased utilization. When used together, these layers also enable unique levels of developer productivity in creating modern applications.

The Joyent SmartMachine provides the first level of abstraction for an application developer. Similar to virtual machines, SmartMachines reduce the need to manage peculiarities of specific hardware. The advantage that SmartMachines provide over virtual machines is that they are lighter weight and provide greater transparency of execution to the underlying operating system, Joyent SmartOS. Joyent SmartOS uses this visibility to substantially enhance performance, improve hardware utilization, and provide greater flexibility to the Joyent SmartDataCenter.

Based on application requirements, Joyent SmartOS allows SmartMachines to burst onto additional CPUs that are underutilized. The Joyent SmartOS file system provides synchronous copy-on-write replication and is coupled with point-in-time data snapshots for greater fault tolerance. SmartOS’s aggressive in-memory caching of data provides greater I/O performance for applications and data retrieval. The SmartOS storage system also employs thin provisioning for dynamic allocation of disk space on demand, insuring that applications always have the required amount of storage available.

An existing library of numerous SmartMachines optimized for specific uses is ready for immediate provisioning Joyent SmartOS, Zeus load

balancing and traffic management, and MySQL are among the popular SmartMachines that can be created and used immediately for building or extending an application.

The next layer of abstraction is the Joyent SmartDataCenter. The SmartDataCenter plays two roles: 1) it manages a collection of SmartMachines to ensure that resources are fully utilized and optimized; and 2) it provides a fully programmable API that allows creation, introspection, and manipulation of SmartMachines and other resources throughout the SmartDataCenter.

The SmartDataCenter has been designed to be highly scalable, configurable, and extensible. Some deployments are currently supporting tens of thousands of SmartMachines. The core management technologies have been demonstrated to scale to millions of clients in real-world applications.

Finally, the open-source Joyent Smart Platform builds on the SmartDataCenter to provide developers with a single, unified development platform that enables the entire SmartDataCenter to work like a single computer, regardless of how many underlying computers or physical data centers are in use. On the Smart Platform, developers build a single application. The SmartDataCenter manages horizontal scaling for the platform, expanding the environment as needed.

Joyent Smart Technologies are also unique in the variety of ways they can be deployed – public, private, and hybrid models of deployment are all supported. Joyent offers a variety of licensing models for the software for use in private or third-party public architectures as well. Joyent also provides a hosted instance of SmartDataCenter that is available for on-demand consumption over the internet.

The Joyent Public Cloud

In addition to building the software, Joyent currently owns and operates the largest implementation of Joyent Smart Technologies. Joyent uses SmartDataCenter to manage a series of real-world data centers distributed nationwide and linked over high speed networks. Each of the data centers houses massive computing resources coordinated into a single, multi-tenant, public SmartDataCenter that provides on-demand resources and services to thousands of companies who serve millions of customers with billions of page views each month.

An essential component of Joyent's public SmartDataCenter is the use of hundreds of dense computing pods in each data center. Each pod houses at least 72 gigabytes of RAM and 16 CPUs using high-throughput 15 kps SAS disk drives with redundant 10 gigabit connections to its network. These high performance, high capacity pods can host multiple Joyent SmartMachines.

Within its public SmartDataCenter Joyent provides on-demand resources to its customers that easily scale both vertically and horizontally. Multiple CPU, RAM, and disk configurations can be allocated for any number of dedicated customer applications, with memory, disk, and network I/O scaling dynamically to optimally meet needs. Multiple application processes can be spread along shared CPUs and memory, while increased raw traffic is served with greater network throughput and disk I/O. As a result, SQL and other I/O intensive applications run up to five times faster on Joyent than more traditional cloud infrastructures.Because Joyent's software is so flexible, customers can grow their business applications in smaller increments than would be possible using physical, traditional computing components or even virtual hosting. They can also just as easily scale back their resources during off-peak hours or seasons. For the first time, customers can now grow their business computer use at the same rate they grow their businesses.

Joyent supports small businesses and multinational corporations alike with the same highly efficient and high performance distributed data centers. Customers can purchase data center resources in increments that improve their business processes, not through arbitrarily assigned virtual machines or rack spaces.

Access to Joyent hosting is flexible as well. Customers can choose from various time and resource combinations, ensuring that they only pay for what they need. Resources can be added easily at any time. Month-to-month subscriptions as well as long-term leasing with substantial discounts are available.

For larger companies in need of extensive cloud development resources and internal management, Joyent can provision private or virtual private configurations that meet any enterprise development effort.

Customers, Facilities, and Background

Joyent customers include some of the largest and most innovative customers in the world, including Facebook, ABC, Gilt Groupe, Watercooler, and many others. Thousands of Joyent customers enjoy high performance and reliability on Joyent's multi-city, distributed data centers. With over five years of enterprise cloud computing experience and numerous Fortune 500 client companies as customers, no cloud computing provider has more experience or a better track-record of reliability than Joyent. Backed by a satisfied and growing global customer base, consistent profitability, and financing from firms such as Intel Financial, Joyent is one of the industry's most stable enterprise computing providers.

Summary

Cloud computing has rapidly evolved into a major tool for businesses. Companies can save capital expenses, software maintenance, personnel, and energy costs by shifting significant portions of their business processes to cloud computing platforms. The flexibility of

cloud computing also allows them to more quickly develop and deploy innovative software applications.

Despite fears of lack of data control or application security, cloud computing has proven itself to be a safe, reliable platform for enterprise computing throughout its evolution. In many cases, next-generation cloud-based applications are more secure and perform better than traditional data center-based solutions.

Sophisticated cloud computing technologies, such as Joyent's Smart Technologies, can provide a full range of computing resources for customers. Available for private deployment or within Joyent's fully distributed and massively provisioned public SmartDataCenter, Joyent provides an on-demand enterprise resource on which companies can build and deploy their next-generation applications.

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