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3-10-10

CLOUD COMPUTING
OVERVIEW, ADVANTAGES, AND CHALLENGES FOR ENTERPRISE DEPLOYMENT

Abstract: Information technology is changing rapidly, and now forms an invisible layer that increasingly touches every aspect of our lives. Power grids, traffic control, healthcare, water supplies, food and energy, along with most of the world's financial transactions, now depend on information technology. An emerging IT delivery model called cloud computing promises to significantly reduce information technology (IT) complexities and costs while improving workload optimization and delivery of services. While cloud computing is massively scalable and may provide a superior user experience, it is characterized by new, internet-driven economics. In this report, we explore the key issues and pros and cons of electing to live and work in a cloud environment.

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CLOUD COMPUTING OVERVIEW

Cloud computing is a paradigm shift that enables scalable processing and storage over distributed networked commodity machines. Enterprises that want to reap the benefits of cloud computing must realize that the decision to migrate is neither quick nor easy. Key enterprise personnel must fully understand the cloud services provider's offering

and be ready to discuss the challenges and obstacles both organizations will face together as the enterprise migrates to the cloud. This paper provides a basic overview of cloud technology and reviews several deployment options that can be described as instantiations of the cloud. Potential advantages of using cloud computing -- including scalability, flexibility, and reduced capital and operating expenses -- are reviewed, as are hurdles to successful deployment. The latter include regulatory, performance, security, and availability issues. A brief economic analysis of cloud computing and an overview of key players offering cloud services are also provided.

Keywords: cloud computing, grid computing, scalability, security, software as a service (SaaS), virtualization

BACKGROUND

The extensibility and flexibility of software architectures and the promise of distributed computing have created a concept known as cloud computing. The cloud shifts the centralized, owned-and-operated computing infrastructure model to a fully distributed decentralized paradigm. To enable the cloud, data centers leverage commodity hardware, virtualization techniques, open frameworks, and ubiquitous network access. Cloud computing builds on the grid computing concept adopted by Oracle RDBMS 11g platform that created a "virtual supercomputer" through distributed, parallel processing. Grid computing was generally used to run a few processor-intensive tasks that would normally be run on a high-performance machine. Cloud computing extends this concept to perform multiple tasks for numerous users in a distributed fashion. The network (Intranet or Internet) is employed to interconnect commodity machinery and to deliver services to disparate users. Figure 1 illustrates the cloud infrastructure.

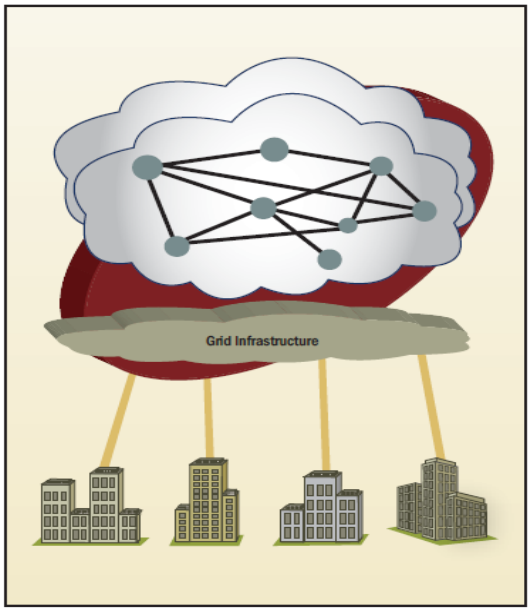

Figure 1. The Cloud Infrastructure

Almost five decades later, the development of new management capabilities, availability of open-source and low-cost software, commoditization of computing, and increase in telecommunications services bandwidth at reduced costs allow the cloud computing model to make technical and financial sense for some enterprises.

CLOUD ARCHITECTURE

Several fundamental components make up the cloud architecture:

- Computing resources are located off site in a data center that is not owned or managed by the enterprise using the cloud services.

- Resources often leverage virtualization for ease of management and interoperability.
- Resources are available on demand.
- Infrastructure is often shared.
- Virtualization can enable multiple customers and applications to share the same physical machines.
- Services are generally provisioned on demand and scaled up or down as required.
- Services are usually subscription-based, with a variety of tiered service offerings as well as flat-rate and per-use pricing models.

These components, fundamentally tied together into architecture, produce a cloud services offering. The architecture of cloud computing can be described using a layered model, in a manner similar to that of the Open Systems Interconnection (OSI) seven-layer model developed to provide an abstract description of layered communications and computer network protocol design. At the top of the cloud model is the client layer, which interfaces directly with cloud environment end users. Below the client layer is the cloud applications layer. Applications that run on the cloud reside here and are generally accessed by application developers. Next is the software infrastructure layer, where basic infrastructure services, including storage, computing, and communications, are performed. Below these three layers are the actual cloud environment software and hardware layers. At the software layer resides the kernel that translates and executes the cloud applications' instructions on the cloud hardware. In much architecture, this cloud software kernel can include a hypervisor for executing virtualized applications. Finally, underpinning all of the cloud layers is the hardware layer, which includes processor, memory, storage, and communications hardware. Figure 2 depicts the relevant layers.

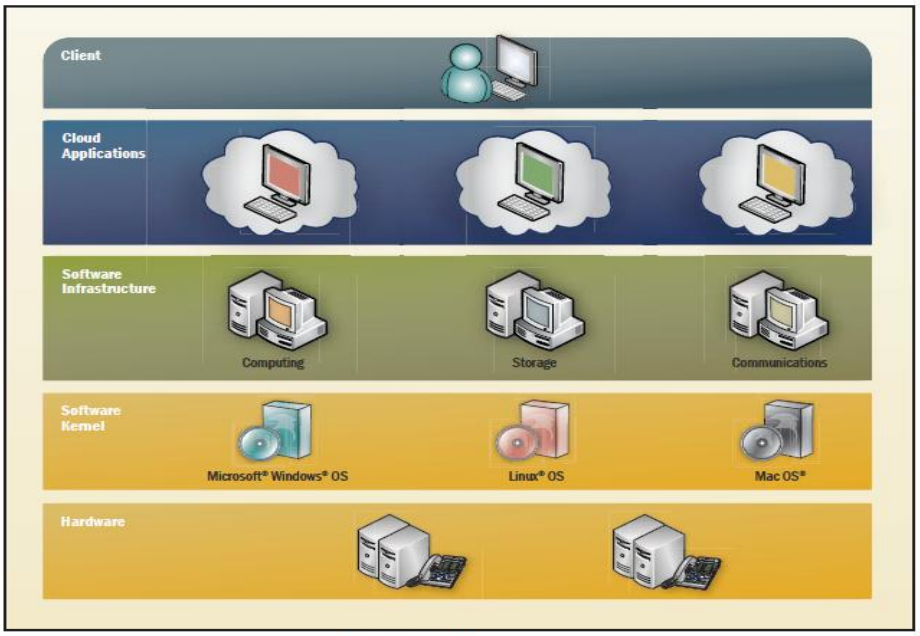

Figure 2. Cloud Layer Model

CLOUD CONCERTS

Cloud computing is really about two fundamental concepts: leveraging economies of scale and improving hardware use. In its current buzzword status, many cloud offerings are quick to associate a service or solution with the cloud architecture. While taking many forms, cloud offerings can generally be sorted into several categories, including:

- Software as a service (SaaS)
- Utility computing
- Disaster recovery
- Application programming interfaces (APIs)
- Managed services
- Large dataset processing
- Cloud integration

Software as a Service

SaaS allows an application to be delivered through a Web browser. The application is generally software and hardware agnostic and relies on server components outside the user's network. The server hardware can be owned and managed by the firm selling the SaaS application, or it can be further removed (in other words, hosted and managed by another party). SaaS is generally characterized in four maturity levels, with the most mature allowing the greatest flexibility, scalability, and reliability. Traditional software firms are beginning to provide SaaS offerings to small- and medium-sized enterprises that often do not have the infrastructure and resources to run larger-scale enterprise applications. Other SaaS offerings include typical productivity and office suites, which can reduce an enterprise's licensing, maintenance, and infrastructure requirements.

Utility Computing

The term utility computing predates widespread use of the term cloud, but is a classic example of the benefits of a cloud infrastructure. Providers offer solutions that enable a virtual data center -- that is, an Internet-enabled commodity processing and storage hardware environment. Enterprises can outsource some or all data center needs to the utility computing provider, often starting with lower-value, routine processing and storage. Current offerings range from on-demand processing and storage up to entire remotely hosted and managed data centers. The cloud paradigm allows these services to be offered via a distributed, flexible, connected topology, rather than through a single data center.

Disaster Recovery

Along with offering traditional server replacement and utility computing options, the cloud also enables a new way to deliver disaster recovery services. Disaster recovery often requires dedicated-specific hardware for data storage and remote applications operations. The cloud paradigm can allow enterprises to use distributed networked

commodity devices to replace dedicated data centers for disaster recovery, thereby reducing the costs to provide this service and, potentially, making it available to a wider range of clients.

Application Programming Interfaces

APIs are becoming a popular way to provide new service offerings while leveraging the cloud infrastructure. APIs allow unique applications to be written and offered via the Web using existing software and services. These applications are software and hardware agnostic and can be run via a Web browser. An application provider can use another provider's Web-enabled services and software and either manage and host the application itself, or allow the existing provider to host the application on its own network.

Managed Services

Managed services, such as remote monitoring and administration, security services, anti-virus scanning, and other back-end offerings, have been prominent for over a decade. However, recent advances allow services offerors to distribute the deployment and management of their offerings, resulting in flexibility, increased reliability, and reduced costs for both the provider and the user.

Large Dataset Processing

Cloud architectures have enabled significantly improved processing of large datasets. The commercially developed Google™ MapReduce – a programming model and associated implementation for processing and generating large datasets -- is particularly efficient and allows distribution, independent processing, and consolidation of analysis, as shown in Figure 3. Apache Hadoop™ is a software product that provides a distributed computing platform for sharing and processing large amounts of data.

The Hadoop project develops open-source software for reliable, scalable, distributed computing; one of its sub projects is a free, open-source version of MapReduce, available for general use. In a recent example of its application, an enterprise needed to process terabytes of data and analyze server use logs to provide better troubleshooting and optimization.

When the datasets became too large for a single, high-performance machine to handle efficiently, the enterprise used Hadoop (including MapReduce) and other Apache™ products to deploy and process the data across 10 commodity nodes. Performance was greatly improved, processing times were reduced, and the system demonstrated significant scalability. APIs allow unique applications to be written and offered via the Web using existing software and services.

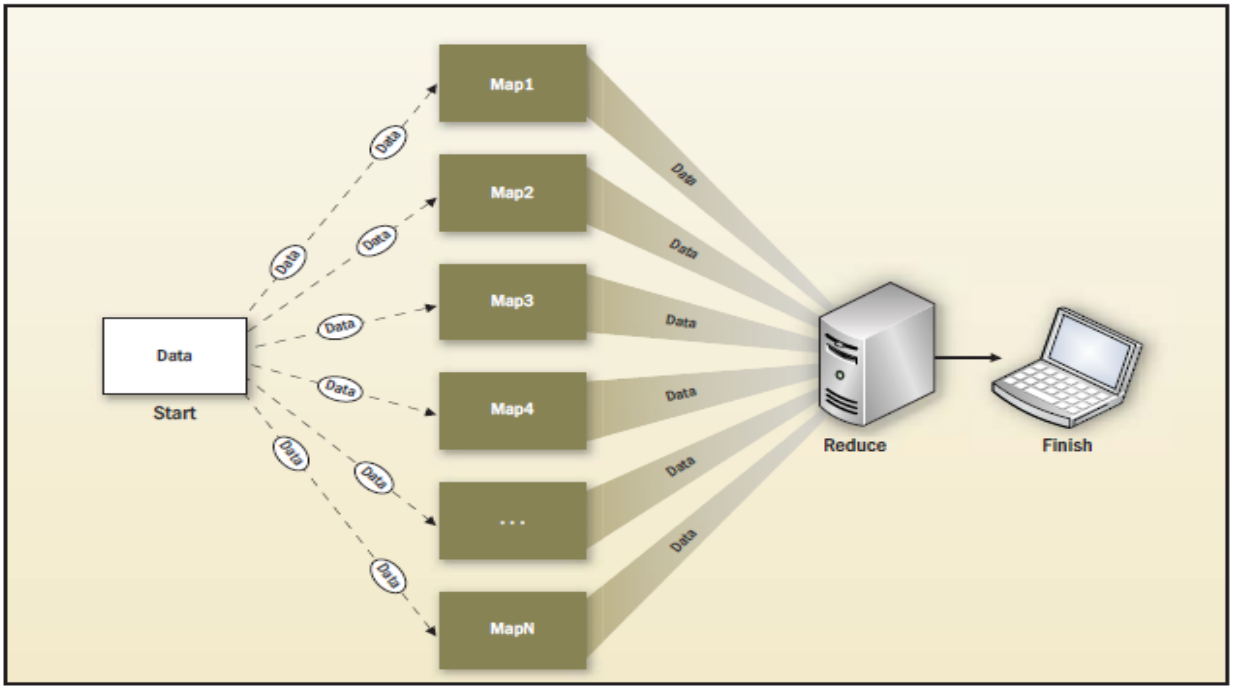

Figure 3. The MapReduce Process

Cloud Integration

While a variety of cloud services scenarios and deployments exist, many cloud offerings are still deployed as "islands". Enterprises may have to integrate data and existing applications with applications deployed on a cloud or integrate multiple cloud applications. A new cloud integration market is emerging, with established and upstart players offering software and services that promise to stitch together disparate applications and services in a cloud environment. Table 1 summarizes the benefits to be derived from taking advantage of the seven cloud offerings just discussed.

CLOUD ADVANTAGES

Table 1. Benefits of Cloud Offerings

Cloud Offering	Benefits over Traditional Model
SaaS	Flexible, lightweight client support
Utility Computing	On-demand storage and service with lower overall costs
Disaster Recovery	Increased flexibility and reduced costs
APIs	Easier deployment of new services using existing cloud
Managed Services	Flexibility, increased reliability, and reduced costs
Large Dataset Processing	Increased performance and scalability
Cloud Integration	Linking of disparate services using cloud infrastructure

The overarching benefit of the cloud is simple in theory—it offers computing that is better distributed and managed as a result of applying economies of scale. These economies of scale are realized by moving the computing hardware from a myriad of enterprise data centers to centrally managed, distributed data centers run by firms that exist for the purpose of operating such data centers. The distributed hardware is less expensive for enterprise users because they share purchasing, operating, and maintenance costs, while the cloud operators leverage their expertise,

purchasing relationships, and management abilities. This model results in advantages, discussed in the following paragraphs that potentially benefit enterprises using cloud services as part of their information infrastructure.

Desktop Support

Cloud infrastructure can flexibly support and reduce costs for both desktop virtualizations and traditional desktop services. Enterprises do not have to maintain a software baseline, end-user licenses, drivers, version control, and multiple images for either type of deployment. Furthermore, cloud computing can enable an enterprise to detach end-user hardware from its managed services, allowing individual users, departments, and groups to own and manage this hardware according to their specific needs.

Mobility and Flexibility

Cloud infrastructure can potentially support better mobility and flexibility, giving end users a consistent look and feel while providing them access to the same set of services and resources from disparate locations. A user's applications, documents, and services thus look the same in the office, at home, or anywhere else an Internet-connected computer is accessed.

Cost and Operational Advantages

For large enterprises, on-demand computing offers significant cost and operational advantages. In a recent example, a large enterprise set up, executed, and tore down a computationally intensive process on a virtual server in only 20 minutes, at a cost of $6.40. To achieve the same results with dedicated physical hardware, the process would have taken 12 weeks and cost tens of thousands of dollars. When the process was complete, the enterprise no longer had to manage or disposition the hardware.

Scalable Services

An enterprise's computing requirements are never static and often peak around a specific time or event. As a result, the enterprise plans and designs its data center hardware and network to handle the maximum computing requirement, which results in idle capacity. This approach not only is inefficient from a capital and operational perspective, but can also prove to be an engineering challenge. When peak demand is greater than forecasted, capacity cannot easily be added to the infrastructure to immediately address that demand. This can result in lost revenues; unhappy customers; and, potentially, a strategic competitive disadvantage. The cloud utility computing model can make scalable services available on demand. The enterprise pays only for services used, while knowing that the scalability to offer additional resources is available. In a recent US presidential town hall meeting, the White House used a commercial provider to augment network and server capacity to support the additional demand on its network.

Private and Hybrid Clouds

Large enterprises that own and manage their own infrastructure have the ability to leverage private clouds, where services are provided via a cloud implementation with some or all hardware and resources managed by the infrastructure. Software and interfaces developed to allow cloud resources to perform in a shared environment can be obtained, licensed, and deployed on an enterprise's hardware and network, allowing scalable deployment of a cloud infrastructure without relying on an outside service provider. Private clouds can also leverage desktop virtualization, SaaS, and other flexible information technology (IT) offerings. Processing advantages using both proprietary and open source algorithms (such as Hadoop) can be realized by deploying private clouds. However, the private cloud still forces an enterprise to retain ownership of and maintain server hardware, which removes the single largest advantage of cloud computing. A potential new approach may be a hybrid of a private and public cloud. In this hybrid, hardware manufacturers or cloud offerors construct a private hardware and software network, either carefully coordinated with the customer or in a separate managed environment that is purpose-built and maintains the integrity of the customer's data in an air-gap environment. This model can leverage the provider's hardware and software pricing economies of scale, as well as the provider's expertise in managing such services, while providing the customer the advantages of a private cloud.

Cloud Software and Applications

Cloud benefits will be further realized as software is designed around the cloud. Today, many applications have been designed and written to run as a single instance serving one set of users from a single server. New applications can be written to perform better in a cloud environment and purpose-built to work in that distributed architecture. These applications can be designed to scale so that additional servers, users, or capacity can be added without modifying a single line of code. New applications can also be written to balance the load so that multiple, identical instances of the application exist on multiple servers, with varying users accessing these servers without noticing a difference. These identical instances allow efficient and elegant recovery from failure or disruptions.

CLOUD CHALLENGES

With the advantages that cloud computing offers, enterprises should be lining up to adopt the new model and to begin migrating infrastructure to the cloud or purchasing new cloud services. While there has been an uptick in demand, significant challenges still need to be addressed before an enterprise can effectively leverage the advantages of the cloud.

Security

A key concern for any enterprise deploying cloud computing is security. A key concern; is data protected now that it is no longer within the confines of the data center, but is

instead distributed and traversing the Internet? In a recent poll, IT executives cited security as the number one hurdle to deploying cloud services, as seen in Figure 4. Enterprises interested in deploying cloud services must consider the security of both the service provider and any hosting services the provider uses. An independent analysis of the hosting provider may afford better insight into the end-to-end security of the implementation. The jurisdiction where the data is held poses another security issue. An enterprise may be operating in Europe, where privacy laws are strong. It may also use a provider that hosts services in the United States, a jurisdiction more favorable to lawful data interception. A potential solution is to have the cloud services provider act as the data custodian only, not as the owner. End-to-end data encryption further removes the cloud provider from data ownership. While some contend that cloud computing services can lead to less security, several logical arguments point, instead, to enhanced security. Human error is the single largest cause of security breaches.

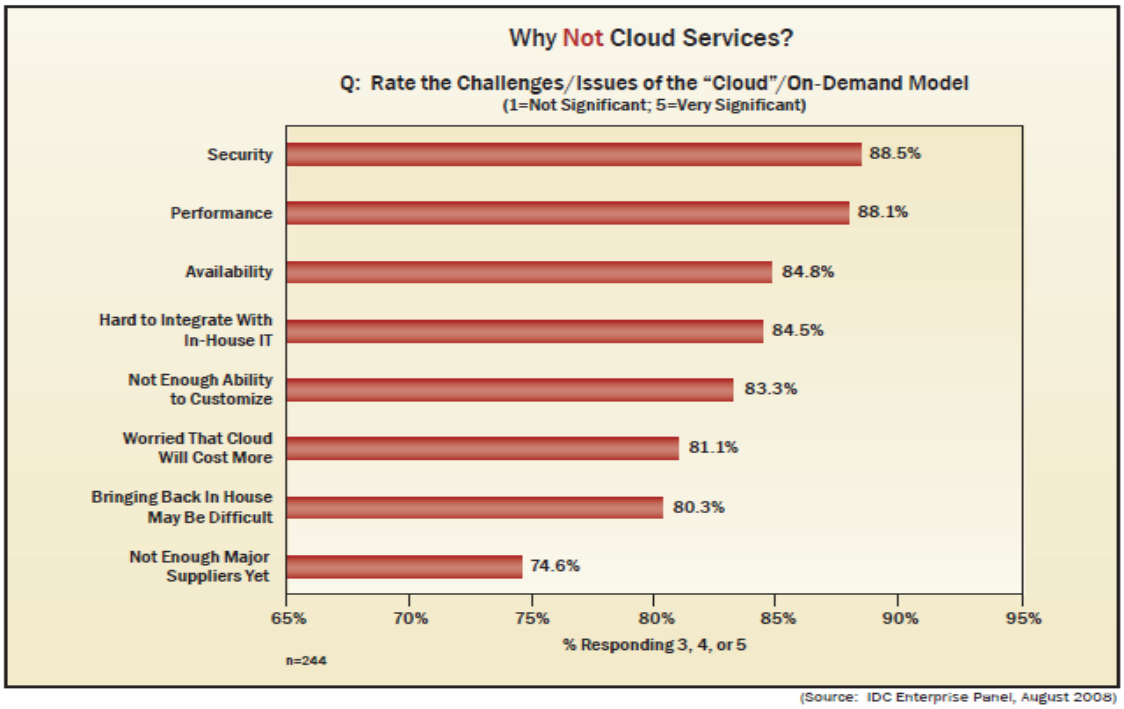

Figure 4. Poll [12]

To remove humans from the equation, large-scale cloud operators automate as many processes as possible. Employee access to data is another significant security issue that can be managed by removing large amounts of readily accessible data. This may increase the level of security. To improve security, cloud proponents advocate moving data that is at rest off of personal machines because documents, databases, and other files are often the target of enterprising thieves. Moving this data to the cloud, where it can be accessed only by legitimate, authenticated users, increases the security level. Thus, a stolen laptop is simply a piece of hardware that needs to be replaced, not a data breach that costs thousands of hours and dollars to mitigate and potentially results in lost revenue and customers.

Another argument put forth by cloud proponents is that the economies of scale leveraged by the cloud extend to security. Large-scale providers of cloud infrastructure have significant expertise, resources, and capital to address security issues. Purpose - built, secure architectures maintained by security experts have the potential to out perform those developed by firms whose core competencies lie outside of IT.

Availability and Reliability

Along with security, IT executives cite availability and reliability as key concerns when migrating to cloud services. Large providers of cloud services have suffered from outages and performance bottlenecks. While service-level agreements may include penalties for downtime, enterprises are not reimbursed for lost revenues and lost customers. The choice for enterprises comes down to whether they feel they can operate their infrastructure more reliably than an outside party, as well as what components and services, in terms of risk and availability, they want to control in house versus extending to a cloud infrastructure.

Regulatory Hurdles

Regulatory hurdles may also prove challenging for cloud providers. Legislation may be enacted that can affect location, use, and disclosure requirements for personal and financial data. For example, the Health Information Portability and Accountability Act (HIPAA) of 1996 requires personal health and identification information to be protected and encompasses protecting it from unencrypted transition over open networks or from downloading to public or remote computers. HIPAA also requires security controls, including access control and audit policies. One cloud storage provider claims to offer a solution that meets all HIPAA requirements for privacy and security. However, enterprises dealing with this type of data must thoroughly understand the regulatory requirements and ensure that the cloud provider meets or exceeds them.

A regulatory hurdle for government agencies seeking to take advantage of the cloud paradigm is information security legislation such as the Federal Information Security Management Act (FISMA). Compliance with FISMA requires an agency to explicitly define the security controls of any new IT system prior to its authorization for use. This extends to any services provided by “any other agency, contractor, or other source.” When an IT system is outsourced to a contractor, the new system must have security processes and procedures identical to those of the system being replaced. This hurdle can be overcome by close collaboration between the agency and the provider and the application of clear, thorough requirements.

Interoperability and Portability

Finally, data and information interoperability and portability can pose a challenge for those wanting to use cloud services. Enterprises will want the option to:

- Change cloud providers without reconfiguration

- Migrate between self-managed an cloud-managed services
- Deploy new applications and services, either on their own hardware or on cloud hardware, that will have to interface with the existing services

This challenge also extends to applications and data management with respect to the need to use different management tools and techniques to interface with data on and off the cloud. Standard, well-defined and documented interfaces, both for application and management traffic, can reduce potential interoperability issues.

Addressing the Challenges

The potential pitfalls associated with cloud service deployment have given pause to some major cloud services providers. As a result, several of these providers, along with enterprises wishing to benefit from cloud computing, have joined together to publish the Open Cloud Manifesto. This document is intended to encourage a dialogue among the providers and users of cloud computing services about the infrastructure requirements and the need for open, interoperable standards, including appropriate existing and adopted standards, as well as new standards when warranted.

ECONOMIC ANALYSIS OF CLOUD MODELS

Table 2 compares and contrasts the traditional and cloud infrastructures with respect to some of the advantages and challenges of cloud computing just discussed. Any economic analysis of cloud models must be performed against this backdrop. To determine whether migration to the cloud is economically viable, an enterprise must compare the costs of the cloud's wide-area network bandwidth, storage, and central processing unit (CPU) with the costs of its own network, hardware, and software. Complicating this process is the amortization of power, space, and cooling costs across the enterprise equipment, as well as the cost of operations with this equipment. Calculating and allocating both of these costs is challenging. One estimate is that computing, storage, and bandwidth costs actually double when the facilities costs are amortized across them. In this context, a strong supporting argument for migration can be made that the economic benefits of the cloud architecture come from its elasticity -- the ability to add or remove resources quickly and easily as required. Since data centers are often provisioned for peak load, actual server use can average as low as 5%. In a model cited by the University of California at Berkeley, a data center with peak use of 500 servers, trough use of 100 servers, and average use of 300

Table 2. Traditional Infrastructure Versus Cloud Infrastructure

	Traditional	Cloud
Performance	—	✓
Scalability	—	✓
Cost	—	✓
Security	?	?
Flexibility	?	?
Manageability	?	?
Availability	?	?

servers would spend 1.7 times as much on server hardware as is actually needed to meet the average demand over a 3-year period. Along with its financial analysis, the study by the University of California at Berkeley cited above recommends that a detailed analysis be conducted of the performance, bandwidth, and processing time requirements of any application to be executed via a cloud. While the cloud model may make sense financially, other performance parameters may prevent deployment in the cloud

SUMMARY OF CURRENT CLOUD PROVIDERS

A variety of cloud computing services providers exists today, with new entrants and modifications in services offerings common. Current key players include:

- Amazon Web Services LLC (AWS)
- Dell Inc.
- Salesforce.com
- Hewlett-Packard™ (HP)
- International Business Machines (IBM)
- Sun Microsystems (acquired by Oracle)
- IBM

Development Resources

- Check out Microsoft's cloud services.
- Business Value of SaaS Integration Analyst Paper
- Capacity Planning 2.0 Handbook
- What are your Top 10 web application performance issues?

Amazon, famous for the infrastructure that powers its online retail service, has leveraged that infrastructure to provide a portfolio of services known as Amazon Web Services™. AWS's offerings include:

- Amazon Elastic Compute Cloud™ (Amazon EC2™), which provides configurable on-demand computing capacity in the cloud
- Amazon Simple Storage Service™ (Amazon S3™), which is scalable, distributed storage
- Amazon SimpleDB™, which leverages the cloud to provide database services

AWS has stated that its cloud services have now used capacity beyond the excess needed for internal operations. Oracle® has also partnered with AWS to deploy Oracle software and back up Oracle databases in the AWS cloud computing environment. Dell, the personal computer manufacturer, recently established its Data Center Solutions (DCS) division to offer design-to-order cloud computing hardware and services under the rubric Dell Cloud Computing Solutions™. One DCS offering includes hosted rental of CPU cycles per hour, which is essential to providing on-demand capacity. Salesforce.com, the online customer relationship management firm, is offering its

Force.com platform, which provides a programming model and cloud-based run-time environment where developers can pay on a per-login basis to build, test, and execute code.

Underpinning this platform is the already widely used Salesforce.com infrastructure. HP has offered cloud computing services since 2005. Dubbed by HP as Flexible Computing Services™, this offering provides computing power as a service in a utility model. Hardware and software giant IBM has introduced a suite of services known as IBM Smart Business. IBM also offers hardware, software, and configuration assistance for enterprises interested in deploying private clouds. Sun has announced its forthcoming Sun Cloud, a public compute and store infrastructure targeted at developers, students, and startups. Sun, like other companies, also provides hardware and software for private clouds, as well as technical assistance. This review of current providers is by no means all inclusive. In addition to these established firms, many small- and medium-sized startups are providing a variety of competitive cloud offerings by leveraging their infrastructure or building services on top of the infrastructures provided by the key players. For up-to-date information on vendors and services, refer to reference materials or contact providers directly.

Oracle’s Acquisition of Sun and Cloud computing

When Oracle executives reported Q2 earnings, CEO Larry Ellison stated that with the acquisition of Sun, Oracle will be able to deliver, “a complete private cloud to our customers.”

Oracle Innovations Behind Cloud Computing

Cloud computing is a relatively new term that has been enjoying a splash of media attention. But many of the innovations that make cloud computing possible have been maturing at Oracle for decades.

There are many "public" cloud-computing services, such as Google App Engine and Amazon EC2 that offer businesses a way to create and access applications with no infrastructure setup, minimal management, and low up-front costs. The challenges created by these public cloud services can become evident, however, when you attempt to integrate them with other applications in your infrastructure, or when you need to keep tight control of your data or quality of service.

A Natural Evolution for the Enterprise

With a long history of grid computing expertise and the industry's most complete and integrated middleware, Oracle offers IT departments the ability to provide the benefits of cloud-- elastic computing capacity and self-service deployment -- in a private or internal service, while avoiding some of the downsides of public cloud.

"A private cloud is a natural, evolutionary step for the enterprise," says Alex Andrianopoulos, vice president of product marketing for Oracle Fusion Middleware. "Using an integrated set of Oracle technologies, an IT team can provide departments and divisions throughout an enterprise with a platform that delivers all the advantages of cloud computing but allows them greater freedom to integrate current resources and control quality and security."

Oracle Technologies Behind Cloud Computing

A platform-as-a-service (PaaS) private cloud is an architecture for centralized, shared resources, internal to the enterprise that allows departments to rapidly deploy and easily manage applications. These Oracle technologies make it possible:

Database grid computing is an architecture that Oracle pioneered in the enterprise. Grid computing enables groups of networked computers to be pooled and provisioned on demand to meet the changing needs of business. With Oracle Database and Oracle Real Application Clusters, Oracle provides the basis for PaaS cloud computing's flexibility and high availability by allowing no single point of failure and enabling businesses to scale incrementally by adding more server nodes as workloads increase. Oracle continues this flexible, scalable architecture into the storage layer with Oracle Automatic Storage Management, which creates a single pool of shared storage that can be provisioned on demand and automatically managed to ensure space utilization is optimized and that I/O bottlenecks are avoided. To manage the entire PaaS cloud platform Oracle Enterprise Manager with Oracle Grid Control provides a single, integrated interface for the top-down administration and monitoring of applications and systems throughout the cloud.

Application grid is a foundation architecture that provides the dynamic resource adjustment that enables PaaS cloud computing's elastic qualities at the application layer. Application grid leverages the capabilities of several Oracle Fusion Middleware components, including Oracle WebLogic Server, the world's #1 application server, with superior clustering and management capabilities; Oracle Coherence, the industry's premier in-memory data grid; Oracle Tuxedo, the industry's #1 distributed transaction processing platform; and Oracle JRocket, the world's fastest Java runtime.

Oracle SOA Suite and Oracle BPM Suite allow developers to build and orchestrate reusable services and components so business users can quickly assemble and manage applications in the PaaS cloud. The integrated, best-of-breed SOA product suite helps developers rapidly design, deploy, and manage Java services, while a complete set of BPM tools allows them to create, execute, and optimize business processes.

Oracle WebCenter Suite provides your PaaS private cloud with a self-service portal interface as well as giving business users the ability to quickly assemble user interface components into composite applications and tailor cloud resources to their needs. The suite offers a complete, open, manageable platform that empowers both developers and

business users to build, deploy, and evolve next-generation composite applications, user interface components, and portals.

Oracle Identity Management allows business users to centrally manage identities and security for both building and using the various applications in a PaaS cloud. Oracle offers the most complete and best-in-class suite of identity management solutions for controlling the end-to-end lifecycle of user identities across all enterprise resources both within and outside the firewall.

These technologies provide a way for your enterprise to adopt PaaS private cloud incrementally by progressing through various levels, or degrees of "cloudyness," such as self-service enablement, elastic capacity, and so on.

"Working toward the goal of a platform-as-a-service private cloud is a great way to begin integrating your current architecture so your business can have more flexible processes," says Andrianopoulos. "It even makes it easier to bring public cloud services into the mix with consistent management and security."

IBM Smart Business cloud solutions

IBM Business Consulting Services: IBM Strategy and Change Services for Cloud Adoption - Leverage our experience to develop a successful, cost-effective cloud IT strategy, tailored to your specific needs.

IBM Strategy and Change Services for Cloud Providers - For cloud providers: we'll help you identify an overall cloud business strategy, including a business model and operating strategy.

IBM Testing Services for Cloud - Understand the extraordinary business value of migrating testing to a cloud-based environment, with a strategic roadmap and business case.

Whether you choose to build clouds behind your firewall or access via the IBM cloud, these secure workload solutions provide superior service management and new choices for deployment.

Development & Test

IBM Smart Business Development and Test on the IBM Cloud: Accelerate your software application development and test efforts. Eliminate provisioning delays; improve software utilization and lower deployment costs for your applications.

IBM Smart Business Test Cloud: Test applications securely behind your corporate firewall with automated, self-service provisioning. Reduce IT costs while simplifying management and improving application quality.

Information solutions

- IBM Smart Analytics Cloud: Discover real-time business insights. Access and analyze multi-source data with this on-site analytics solution for the enterprise.
- IBM Smart Business Storage Cloud: Manage massive information demands while reducing costs and enabling enterprise-wide file sharing and collaboration.
- IBM Information Archive: Archive all types of information (e.g., regulatory) controlling IT costs, managing risk and improving productivity.

Collaboration

- IBM LotusLive™: Unleash employee potential with world-class social networking services and on-line collaboration tools, including file sharing, web conferencing and instant messaging—all through your Web browser.
- IBM LotusLive iNotes™: Enable the entire enterprise with secure, cloud-based service for e-mail, scheduling and contact management. Reduce costs and manage resource constraints while maintaining corporate e-mail policies and controls.

CONCLUSIONS

Essential Considerations before Jumping on the Cloud:

- Educate yourself on the issues
- Choose the right cloud
- Test the Cloud with your Existent Virtualized Infrastructure
- Choose the right applications

Thinking about jumping on the cloud?

There is no question Plant-Wide has shown its skepticism towards the marketing of 'cloud computing' versus the technology involved being no more than a repackaging of solutions which have existed for years, but we also must admit the fact is it still addresses a concept and reality that exists and one which holds numerous benefits. Indeed abandoning an existing on-site IT infrastructure for a cloud provider that most often or not can't offer the same level of security, control or performance is not an easy decision but one which CIOs and IT executives are seriously considering when weighing up the economic benefits. As with any change though, a move towards the cloud necessitates a sound and comprehensive assessment to avoid the trap of a short term benefit turning into a long term nightmare.
Integration Considerations

First your company should assess its business strategy and whether a cloud computing infrastructure could integrate with it. With all the convenience that cloud offers, the risk of data residing beyond your company's vicinity still presents a significant security risk. Hence depending on your company, whether that is a startup, small, medium or

enterprise an assessment of how much risk you are prepared to take in order to cut costs will initially be the first factor in deciding which data/applications to outsource to the cloud. This is what often leads enterprises to be content with using the cloud for archival while smaller business find it easier to go the whole nine yards. Once that's decided, your design for integration should first evaluate each process and system and determines the number of simultaneous requests that need to be handled. As always availability of information also needs to be paramount, regardless of whether the information resides internally or on the cloud. Thus the key for enterprises is to not think of the cloud as a substitute for their processes, policies and security but rather an extension of their existent architecture.

As enterprises realize the benefits of the cloud, it is possible that cloud computing will become as ubiquitous as client-server computing, virtualization, and other architectures that brought about a technological paradigm shift. It is also possible that cloud computing is overhyped and oversold, much like previous concepts that claimed to be the next big thing. However, enterprises are experiencing real benefits from using cloud computing. Enterprises that want to reap the benefits of cloud computing must realize that the decision to migrate is neither quick nor easy. Key enterprise personnel must fully understand the provider's offering and be ready to discuss the challenges and obstacles they will face together in migrating to the cloud. Through close, open collaboration with cloud providers, enterprises can focus on delivering the right technologies and services to their personnel and customers while using new technologies and architectures and realizing cost and operational benefits.

Interest in cloud computing by the government is also running high.

A GovIT Session at Cloud Expo 2010 East on March 14, 2010 explored cloud computing with Army Knowledge Leaders (AKL)! AKL is an intensive 2-year experience of training and work rotations designed to develop leadership, business and technology competencies to support the Army Chief Information Officer (CIO) mission (Clinger-Cohen Act of 1996). In doing this, the Army is cultivating a new breed of IT leaders for a knowledge-centric organization. Program participants are self-starters and lifelong learners with solid peer/mentor relationships and a commitment to public service. Through the use of a cloud computing mind map, these knowledge leaders covered many aspects of cloud computing, including: Definition and characteristics Use cases and operational requirements Security concerns and techniques Industry standards Cloud computing reference model Mission.

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- Mission driven solution design; and
- Adoption and expansion process

Cloud Computing for Executives: Your Own Private Cloud?

Large enterprises that own and manage their own infrastructure have the ability to leverage private clouds, where services are provided via a cloud implementation with some or all hardware and resources managed by the infrastructure. APIs allow unique applications to be written and offered via the Web using existing software and services "A platform-as-a-service private cloud builds on a number of existing technologies, like service-oriented architecture, application grid, and systems management automation," says Mike Piech, senior director of product marketing for Oracle's application grid products. "This means you can leverage your middleware technologies in a cloud-like way to incrementally get to private PaaS."

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Sources: Based on a Bechtel Technology Journal, IBM, Microsoft, and BusinessWeek, technology reports, Cloud Computing Journal and other industry and media reports.
