What the Enterprise Needs to Know about Cloud Computing

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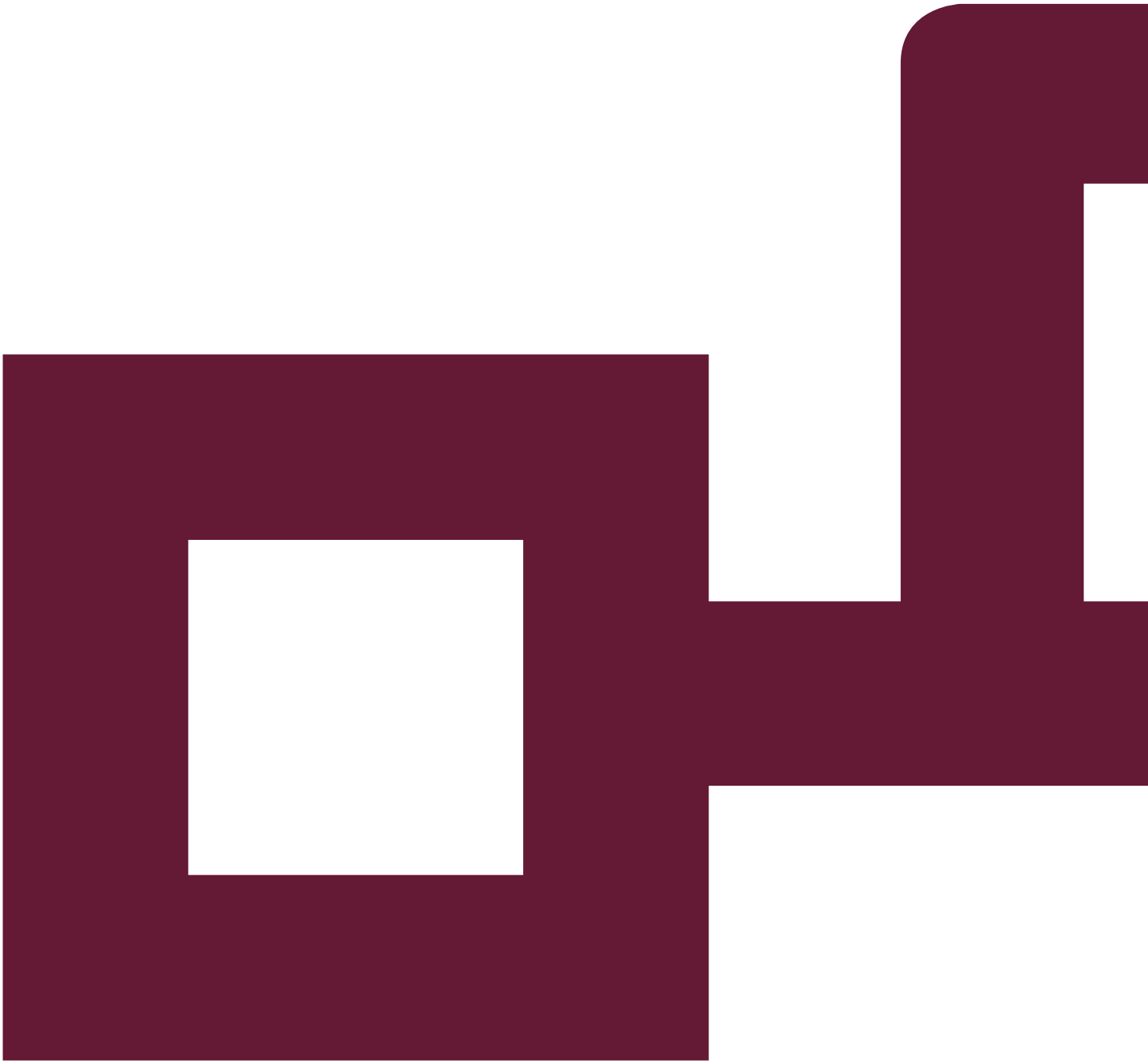
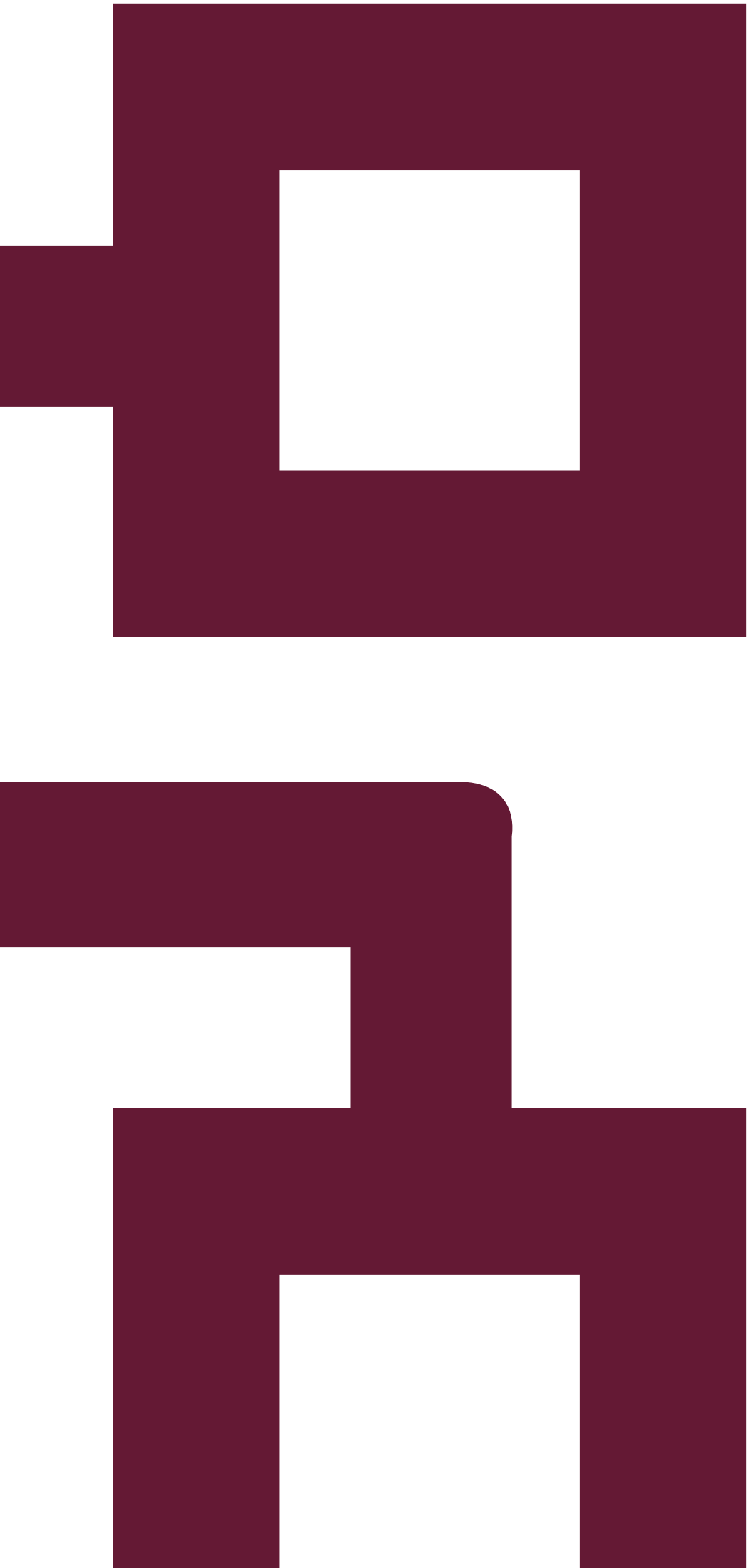




Cloud computing is heralded as the next big thing in enterprise IT. While corporate data centers and on-premise software are not going away anytime soon, "the clouds" will likely have a growing impact on enterprise IT and business activities in many large organizations. CIOs and other business leaders must look beyond the hype to see what opportunities and challenges lie in the cloud—and how this approach can be used to further the organization's strategy to achieve high performance.

Although the term "cloud computing" is quite recent, elements of the concept have been around for years. For instance, timesharing and virtual machines date back to the mainframe era in the 1960s. The notion of "the network is the computer" was first coined by Sun Microsystems in 1982. Grid computing, in use by the scientific community since the early 1990s, has been widely deployed in financial services for the past five or six years, especially in securities and trading operations. Even the on-demand business model dates back to the late 1990s, when it was served up by organizations known as application service providers, or ASPs.

What makes cloud computing real now is the maturation of the Internet as an IT platform, virtualization, hardware commoditization, standardization, and open source software. A key catalyst is the success of major Internet companies like Google, Amazon and Microsoft. The highly global and scalable infrastructure these companies have built to power Internet search, electronic commerce, social networks, and other online services forms the core of the current cloud phenomenon.

Early evidence shows that cloud computing is clearly upon us. Citigroup recently purchased 30,000 seats of Salesforce's customer-facing software-as-a-service (SaaS) applications for its financial advisors worldwide.[1] Contract manufacturer Flextronics has said it will use human capital management solutions from SaaS newcomer Workday for its 200,000-plus employees around the globe.[2] Coca-Cola is moving 35,000 knowledge-workers from Lotus Notes to Microsoft Exchange Online.[3] NASDAQ turns to Amazon.com's S3 to store historical data on stocks and funds and a lightweight rich Internet application to generate new revenues.[4] Infosolve Technologies, a provider of data quality solutions, relies on Sun's Grid to scrub customer data.[4] Semiconductor maker Advanced Micro Devices (AMD) turns to the same cloud from Sun for product testing and simulation to achieve faster time to market.[5]

Cloud computing should be considered another important step forward in the continuing industrialization of IT and could thus play a future role in enabling high performance. The changing business model, underlying technologies and architecture will likely create a new wave of innovations. For enterprise IT users, the cloud holds great potential in delivering lower-cost services, greater IT agility, more flexibility and better user experiences. Indeed, Accenture High Performance Business research identifies virtualization—a major enabler for the cloud—as a key contributor to high-performance IT.[6]

The cloud also presents a number of new challenges in data security, privacy, control, compliance, application integration, and service quality. To be successful, companies should take small, incremental steps toward this new environment so they can reap early benefits for applicable business situations, and learn how to deal with the associated risks.

The evolving enterprise IT stack

The term "cloud computing" is known by many other names, including on-demand computing, elastic computing, utility computing, grid computing, and everything-as-a-service. While each captures facets of the phenomenon, these terms fail to tell the whole story. Here, we define cloud computing as the dynamic provisioning of IT capabilities (for example, hardware, software or services) from third parties over a network. By combining virtualization and one-to-many architecture with a pay-as-you-go business model, cloud computing represents a new paradigm that will significantly impact the way IT infrastructure, platform, application, and business processes capabilities are procured, delivered and supported.

• At the infrastructure level, companies have already begun to source raw computing resources—processing power, network bandwidth and storage—from the outside on an on-demand basis. In most cases, these resources are currently used to augment rather than replace existing in-house infrastructure, which itself is increasingly virtualized (a phenomenon known as "internal cloud.") Unlike traditional hosting services, which provide dedicated hardware to each customer, infrastructure cloud providers draw from a vast pool of shared resources and dynamically expand and contract to accommodate fluctuating demand from different user organizations. As a result, they provide far greater elasticity, economies of scale and cost advantage compared to standalone datacenters. Amazon's Elastic Compute Cloud (EC2), Sun's Grid Compute Utility, and VMware's vCloud are prime examples.

1 *Computerworld UK*, "Citigroup signs 30,000 seat deal with Salesforce.com," November 16, 2007.
2 *BusinessWeek*, "Workday: The Next Software Power?" August 19, 2008.
3 *InformationWeek*, "Coke's Largest Bottler Taps Microsoft For SaaS," July 19, 2008.
4 *InfoWorld*, "Early experiments in cloud computing," April 7, 2008.
5 *ChannelWeb*, "AMD Taps Into Sun Utility Grid," September 7, 2006.
6 "High Performance IT 2008: There's No Substitute for Substitution," Accenture, 2008.

• At the platform level, cloud-based environments provide application developers similar functionalities as in the traditional desktop settings. Specifically, these include tools and other support for development, testing, deployment, runtime libraries and hosting. The emergence of such platforms allows independent software vendors (ISVs) and IT staff to develop and deploy online applications quickly using the third-party infrastructure. In the case of force.com, for example, developers can also take advantage of the existing data and customer base from the core customer relationship management (CRM) application. Google App Engine and Coghead are two other examples. Microsoft recently announced its Windows Azure service platform, which extends its leading desktop capabilities (such as .NET) into the cloud.

• At the application level, the first wave of cloud-based services (also known as software-as-a-service or SaaS) falls broadly into the areas of CRM, human capital, and financial management. The second wave focuses on desktop productivity tools, including word processing, spreadsheets, e-mail and Web conferencing. Today, application clouds span across all major enterprise solution areas, from procurement to enterprise resource planning and content management. These applications run on the third-party infrastructure. User organizations subscribe to these services based on the number of users or seats. Since these services are available via standard browsers, they support device-independence and anywhere-access. Major pure-play vendors include Salesforce, NetSuite, Workday and Google (Google Docs). Traditional enterprise software providers such as Oracle, SAP and Microsoft have also begun offering their own hosted applications.

• At the business process level, cloud-based solutions, also known as business process utilities or platform-based business process outsourcing (BPO), offer an Internet-enabled, externally provisioned service for managing an entire business process, such as claims processing, expense management or procurement. Unlike traditional BPO, which requires the service provider to take over an existing software installation, the process cloud uses a common, one-to-many platform to automate highly standardized processes. It differs from application clouds in that it provides end-to-end process support, covering not just software but also processes supported by people, such as contact centers. These processes are typically priced on a per-transaction rather than per-seat basis. Early examples include PayPal (consumer micro payments), ADP Employease (payroll), and Amex-Concur (business expense management).

As shown in **Figure 1**, cloud-based services are available at all levels of the enterprise IT stack. So far, each layer has evolved independently. Application clouds are perhaps mature, while business process and platform clouds are still at a nascent stage. Most application cloud pioneers (for example, Salesforce.com) rely on their own home-grown infrastructure. As infrastructure and platform clouds continue to mature, this scenario is likely to change. New application players will be able to turn to these providers to achieve better cost structure, elasticity and faster time to market. For instance, thanks to Amazon EC2 and open source software, the upstart Coupa successfully launched an on-demand e-procurement solution six months after closing its first round of funding.[7] Potential process cloud providers may follow a similar path to offer virtual BPO without owning their own hardware and software platforms. This reinforcement effect is likely to accelerate the uptake and the long-term success of the cloud ecosystem.

7 www.coupa.com/about/press-releases/e-procurement-software-innovator-recieves-seriesa-funding; www.coupa.com/about/press-releases/first-on-demand-e-procurement-software.

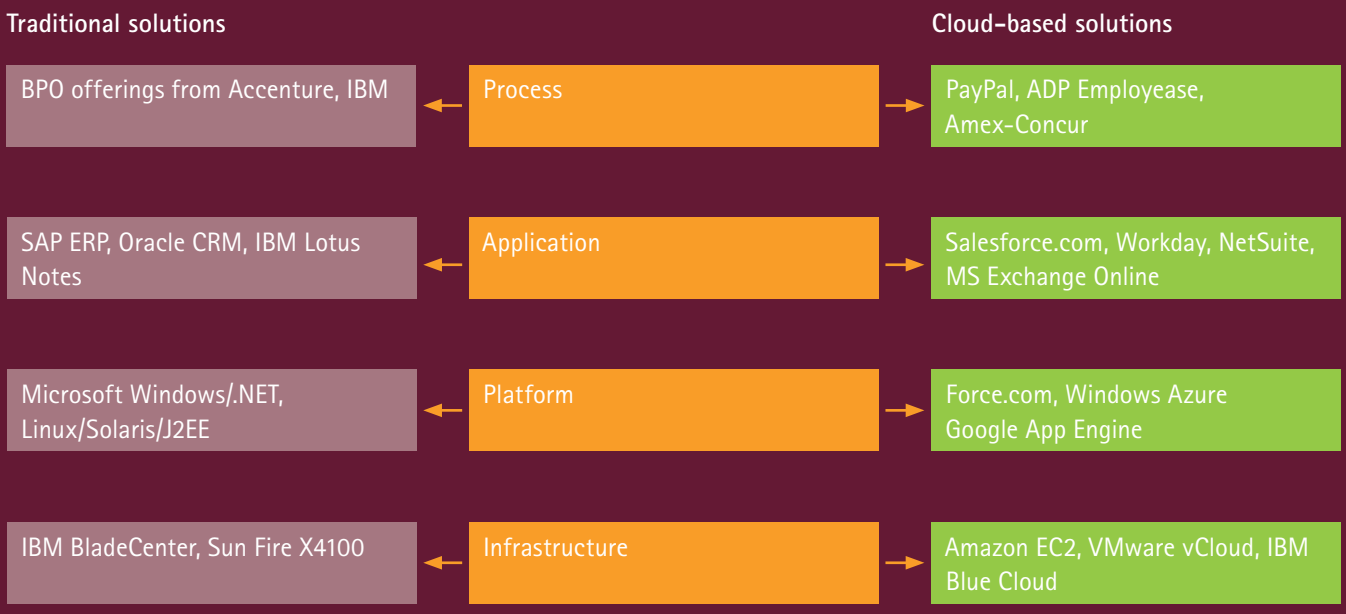
The rise of a disruptive technology

Cloud computing is a classic disruptive technology. As such, it has its origin in the fringe of the IT market, i.e., the small and medium-sized enterprise (SME) and consumers, whose need for simpler and lower-cost or even free solutions is underserved by traditional packaged software. As cloud-based services matured, they started to win broader acceptance from mainstream enterprise customers. Now, they compete directly with on-premise and packaged software.

The significance of the cloud, however, lies far beyond cheap computing. The Web-enabled, variable cost model represents a huge departure from existing practice, and carries far-reaching implications for IT providers and users alike. A new wave of venture-funded startups are likely to appear, offering an array of innovative solutions ranging from niche applications to cloud middleware and infrastructure services. The emergence of cloud platforms will significantly ease the entry barrier for such small players to develop, deploy, scale and integrate their services.

The battle between pure Internet players like Google, Amazon and Salesforce and traditional enterprise vendors has just begun. Incumbents such as SAP, Oracle, and Microsoft have been investing aggressively to extend their on-premise capabilities into the cloud. For example, Microsoft has launched online services to offer its software in the cloud. It is also investing billions in datacenters to help confirm quality and availability. Microsoft has developed a Software + Services hybrid model to offer its customers a choice between on-premise, partner-managed or Microsoft hosted solutions.

Figure 1. The enterprise IT stack: traditional solutions versus cloud-based solutions



For IT organizations, the cloud means that more IT functions will be accounted for as variable costs. This change from "buy-and-own" to "pay-as-you-go" has broad implications for activities such as procurement and staffing—and it could lead to a new role for the IT department. As the cloud continues to gain momentum, more business units and users will turn directly to cloud-based solutions to meet their infrastructure and application needs. As a result, the IT department's role as the sole provider and operator of IT will slowly diminish. At the same time, the IT department will likely see a growing demand for security, procurement, data, and other similar services from the business units.

Accenture believes that the IT departments of large organizations will continue to supply the majority of IT services, especially those enabling core business functions. Nevertheless, these departments must still be ready to accept a gradually shrinking footprint while dealing with new challenges associated with the emerging hybrid environment, including service quality, data and integration.

In general, cloud computing will act as an accelerator for enterprises, enabling them to innovate and compete more effectively. With elastic and theoretically unlimited IT resources on tap, businesses no longer have to wait for the provisioning of servers or worry about project delays. By tapping into the right cloud capabilities, companies can quickly enter new geographical markets or launch new products or services in existing markets. As demand grows, they can quickly scale up. Conversely, when demand eases, they can just as quickly scale down and, if necessary, exit the market entirely with minimum loss of time and capital.

Why now?

Several forces are converging to create the recent surge of interest in the cloud. On the business front, today's macroeconomic conditions continue to put pressure on overall business spending, which drives ongoing IT rationalization, datacenter consolidation, outsourcing and now cloud computing. For organizations eager to delay, reduce or eliminate capital spending, especially on one-off or marginal projects, the pay-as-you-go model provides an attractive option. Increasingly, companies also are turning to cloud-based solutions as a way to counter the high licensing costs of enterprise software.

Another factor pertains to the growing demand for seamless collaboration. As the globalization trend continues, coupled with rising energy prices and widespread concerns about climate change and traffic congestion, distributed work has become an everyday reality in large organizations. Many existing on-premise applications were originally designed to support individuals or same-time, same-place work styles. By contrast, cloud-based productivity tools (for example, Google Apps, Microsoft Office Live Workspace, Intuit's QuickBase, Facebook) are inherently collaborative and accessible anywhere. These same applications are also used by many younger employees outside of work, making them a more natural fit for tomorrow's workforce.

On the technology front, a number of recent developments have combined to make the Internet an emerging enterprise IT platform. At the center is the widespread adoption of Web services, allowing easy publishing, access and integration of application functionalities and infrastructure capabilities from different organizations. For instance, the entire Amazon cloud is accessible through Web services. The second is Rich Internet Applications or RIAs (for example, AJAX, Flash/Flex, OpenLaszlo) which support desktop-like client-side functionality within a browser, including local persistence for offline use, enriched graphics processing, integration with local devices and enhanced user experience. Without RIAs, application clouds such as Salesforce.com and Google Apps would not have been possible. In addition, other advances such as hardware virtualization, multi-tenant architecture, parallelization engines (for example, MapReduce, Hadoop), and grid architecture are essential to support for the elasticity and scalability of the cloud.

A business case for using the cloud

A global logistics company ESB handles tens of millions of packages each day. To help prevent millions of dollars in lost revenues each year due to fraud, ESB looks for a solution that is capable of detecting duplicate barcodes on the shipments originated from different locations around the world. Among its requirements are large data volumes and near real-time response. The table below shows a cost comparison among three different solutions.

These numbers represent a conservative estimate since they do not take into account other costs, including energy, software licensing, and the time lost to setup and testing. The result ($130,000 annual operating cost versus $4 million upfront capital cost) clearly favors using Amazon EC2 over buying, installing and operating one's own servers.

On-premise approach	Using Amazon EC2 public cloud	Buying internal cloud
• SUN E25K: 72CPU + 1 TB memory • TimesTen In-Memory Database	• 150 virtual servers	• 150 servers
• Capital cost = $4-plus million • License cost = $1-plus million/year	• Variable cost = $131,000/year assuming 24x7x365	• Capital cost = $150,000
• Power cost = $70,000/year • 40kW/hour + 40kW/hour	• Power cost = 0	• Power cost = $39,000/year • 45kW/hour

Five major challenges

Just like other technological advances in the past, cloud computing brings major challenges as well as opportunities to IT organizations and businesses. While some of these issues are technical (for example, performance), others are more organizational (for example, data location). How well and how soon these issues are resolved will determine whether cloud computing will eventually live up to its lofty promises.

For most companies, the single most important near-term concern is security, namely, how enterprise data is safeguarded in a shared third-party environment. Since their core business is based on securing customer data, major cloud providers have made strides in this area. In fact, many of them offer more sophisticated end-to-end, base level security and privacy protection than do the data centers in any single enterprise. For example, to preserve the privacy of a customer's data, Amazon augments the standard hypervisor with its proprietary disk virtualization layer that automatically cleans up every block of storage used. The fact that major financial services firms like Citigroup have embraced cloud solutions suggests that the cloud has successfully passed early tests. However, there are still many open issues such as data control and certification. The pace of the future uptake will depend heavily on how soon these issues are resolved, and when cloud providers will be able to obtain official certifications of their security practices from independent third parties.

The second significant problem is around data, including data location, compliance and integration. Current cloud solutions require data to be stored in the cloud. This approach assumes that a company relies on one or two providers at a time. Yet, the current market is extremely fragmented. By some estimates, there are about 700 cloud-based application providers, each specializing in a specific vertical market. Even though consolidation among providers is inevitable, most companies will most likely end up using multiple clouds. As a result, they will have to deal with data scattered across clouds, not to mention the data residing behind the firewall in their own data centers. To further complicate the situation, cloud operators must also meet government regulations that require customer data (for example, banking and health) to reside within specific geographic jurisdictions. This fragmentation of data presents huge integration challenges. It also emphasizes the importance of developing a comprehensive enterprise architecture.

The third major challenge pertains to service-level guarantees. Many enterprise applications require certain levels of service. In the traditional on-premise setting, these requirements are relatively easy to satisfy because the IT department controls the physical and software environment in which the application runs. But this is not true for the cloud. Application cloud providers, which have control over the running environment, cannot guarantee response times because the data has to travel through the Internet. The challenge becomes even greater for the infrastructure cloud, since it essentially supports the software code from other organizations. Despite steady progress made by major providers, this lack of service-level guarantees will prevent critical enterprise applications from migrating into the cloud anytime soon.

The fourth major challenge is related to legacy systems. Legacy applications in general do not adapt well to the cloud. Since such systems are often critical to core business functions, today's cloud infrastructure simply lacks the service levels to support them. In addition, many legacy applications are tightly coupled to the underlying hardware. Without costly redesign, they cannot benefit from the virtualization and parallelization features of the cloud. The mere presence of legacy applications means that a significant portion of IT in large enterprises will not be part of the cloud anytime soon.

The fifth challenge concerns the actual purchase process of cloud-based services. On the face of it, using pay-as-you-go IT services should be highly attractive from a procurement standpoint, moving payment and authorization processes from capital expenditure to operating costs. In theory, this could be accomplished by having individual users pay with their own credit cards, expensing the costs much as they would expense business meals or taxi fares. However, few corporate finance or procurement processes are set up to support such levels of flexibility. The procurement of the cloud, and the whole concept of what an enterprise agreement looks like in a cloud environment, are sticking points that will not be resolved overnight.

A comparison of major cloud platforms

One of the latest trends is that cloud service providers are moving beyond specific verticals to offer integrated platforms to support other developers to create new services. Salesforce, which first introduced the concept, has gradually transformed itself from a CRM specialist into a full-fledged application development and hosting platform. Its force.com currently has more than 70,000 applications developed by third parties, ranging from ERP and human resources to compliance tracking and billing.[8] Through the App Engine, Google also offers a suite of tools that enables developers to develop and deploy their Web applications onto Google's infrastructure. Microsoft recently announced the Windows Azure service platform that extends its rich desktop integrated development environment (IDE) capabilities into the cloud environment.

8 Salesforce.com, "Salesforce.com Announces Force.com Cloud Computing Architecture," January 17, 2008: http://www.salesforce.com/company/news-press/press-releases/2008/01/080117-2.jsp.

The emergence of platforms represents a new phase in the evolution of cloud computing. Just as in the desktop environment, this new development will lead to improved tooling, programmer productivity, market consolidation and, perhaps most importantly, a sustainable developer community. At the same time, it can result in incompatible ecosystems and customer lock-ins. As more companies start to embrace the cloud, they will need to ensure the long-term viability of their chosen platform(s). **Table 1** provides a comparison of the main features offered by the six leading cloud providers.

Even though early cloud players enjoy clear advantages, it is worth noting that the competitive and technological landscape is likely to change dramatically over the next few years. It is therefore far too early to predict which players might eventually succeed. However, those uncertainties should not prevent businesses from using the cloud to meet their near-term IT needs. For example, companies with one-off applications can immediately benefit from Amazon EC2 and S3. Existing or prospective customers of Salesforce should consider leveraging force.com and integrated Google Apps to further extend core CRM capabilities to other application areas, such as collaboration.[9] Large enterprises may find that, over the long run, the hybrid approach from Microsoft and IBM offers them the most sensible way to accommodate their on-premise legacy and growing cloud-based applications.

9 Google, "Salesforce.com and Google Introduce Salesforce for Google Apps," April 14, 2008: http://www.google.com/press/annc/20080414_salesforce_google_apps.html.

Table 1. A comparison of six major cloud platforms

	Description	Strengths	Weaknesses
Amazon Infrastructure Cloud	An à la carte list of infrastructure services: • Elastic Compute Cloud (EC2) • Simple Storage Service (S3) • Simple Queue Service (SQS) • SimpleDB	Ready-to-go, Web-scale infrastructure shared by Amazon.com, true pay-as-you-go usage model, standard Web service interface, language agnostic	• No IDE support • Limited service level agreements • New to enterprise market
Google App Engine	A tightly integrated development and hosting environment for Web applications: dynamic runtime, persistent storage, user authentication, e-mail, service monitoring, log analysis, etc.	Existing, mature Web-scale infrastructure; rich set of Google services application programming interfaces, low entry barrier (free to try)	Request-driven, page-oriented model; no direct access to Google infrastructure; no service level agreements
IBM Blue Cloud	A family of hardware and software for building a private cloud: BladeCenter with Linux-based servers, grid-computing engine, Xen and PowerVM, Hadoop, and Tivoli	• Strong position in back-office and development environments • Open source components • Customizability	Vendor-specific hardware; complexity; high cost
Microsoft Windows Azure	Software + Services hybrid model, same functionality accessible through a set of core Online Services (for example, storage, identity, data service), same application programming interface for desktop client and the cloud	Scale of investment and completeness of vision, large developer community, existing development tools and skills, easier integration especially with other Microsoft-based apps	Limited time in market, complexity due to option of business model
Salesforce Force.com	Hosted development platform evolved from AppExchange with new tools like Visualforce (custom user interface creation) and Apex Code (Java-like language for manipulating business logic and data)	Existing customer base for core CRM application, multitenant architecture, relative maturity	Proprietary language (Apex Code), scalable but not Web-scale infrastructure
VMware vCloud	A virtual datacenter operating system comprising of a set of representational state transfer-based application programming interfaces for managing virtual machines running in a cloud environment, and a set of services (vServices) such as charge-back and service-level-agreement tracking	Support portability between on-premise virtual infrastructure and external VMware-enabled in-the-cloud data centers	Still just an initiative with a lineup of service partners—it is not clear when it becomes a reality

Three ways CIOs can use the cloud today

Under the current economic conditions, CIOs face more pressure than ever before to cut cost and to do more with less. The "pay-as-you-go" model of the cloud provides them with an attractive option to defer, reduce or even eliminate certain capital spending without sacrificing service level. Below are three steps for CIOs to take advantage of the cloud.

• Use the cloud for the right jobs: Today's infrastructure clouds such as Amazon EC2 offer a relatively inexpensive and flexible alternative to buying in-house hardware. They are mature enough for non-business-critical projects including research and development and software development and testing. They are also well suited for computation-intensive jobs, such as data cleansing, data mining, risk modeling, optimization and simulation.

• Target the right users for cloud applications: Instead of buying or renewing software licenses for every employee in the company, CIOs may want to switch some workers to lower-cost, cloud-based solutions based on the type of work they do. For example, workers at contact centers and offshore locations are good candidates for using desktop clouds.

• Take small steps toward an internal cloud: One of the CIO's top priorities is to continue improving the utilization of existing IT resources through virtualization and datacenter consolidation. The same effort will eventually lead to an internal cloud.

A guide for action

Even though cloud computing is still at a nascent stage, businesses and government agencies should take steps now to experiment, learn, and reap some immediate business benefits. Here are a few guidelines on how large organizations might proceed without undue risk:

• **Batch and data-intensive applications**. Today's infrastructure clouds (for example, Amazon EC2 and Sun Grid) provide a relatively inexpensive and flexible source of raw computing power for batch-oriented jobs with self-contained datasets. They are especially suited for data-intensive applications that require heavy CPU cycles but not necessarily real-time network response. Examples of such projects include data conversion, cleansing and mining, data compression and encryption, simulation, risk modeling and graphics rendering.

• **Software development and testing**. For companies with large in-house software projects, moving to a cloud-based development environment (for example, CollabNet) may make sense because it can provide more intuitive support for distributed projects and global collaboration. Since project teams can obtain development resources on the fly, it can also help reduce potential project delays. As a "virtual test lab," a cloud-based testing environment (for example, SOASTA) has a clear advantage for supporting realistic load and performance testing without requiring a cost-prohibitive infrastructure.

• **Research and development**. Research and development projects in large companies may also be good candidates because they are often highly iterative, demanding fast ramp-up and quick scale-up and down—both hallmarks of the cloud. In fact, IBM's Blue Cloud has its origins in an initiative that supports internal research and development projects. For the same reasons, advanced product development groups may also take advantage of the cloud to shorten time to market.

• **Business continuity and disaster recovery**. Large providers of cloud services rely on highly distributed, robust and scalable infrastructure. For example, Amazon, as part of its services, stores customer data redundantly in multiple physical locations. In the event of a natural disaster, such data will be more easily recovered than it would be in an enterprise data center that only stores data in one physical location. Thus the cloud may also be used to back up critical business data in existing enterprise systems. This type of solution could support quicker retrieval, faster recovery and lower cost.

• **Desktop productivity tools.** Companies might be tempted to move commodity applications like e-mail and personal productivity tools into the cloud to save money and to meet the demands of younger employees. However, current desktop application clouds are still not mature enough in terms of feature sets and service levels for such heavy business use. At this stage, they may be best used to augment rather than replace existing productivity suites. Depending on the type and style of work, it makes sense to target select groups within an enterprise for such applications. For example, offshore and contact center employees may be good candidates. Groups that already use other cloud applications may also find desktop clouds appealing.

• **Peak load demands.** There are two broad types of peak load demands: predictable and unpredictable. A good example of predictable peak demand comes up when IT groups at financial service firms have to handle the rush of year-end statements. Similarly, IT departments at large retailers must plan for peak demand during holiday sales periods. In such cases, the cloud can be used to accommodate demand.

Unpredictable peak load is more complex. It requires dynamic load balancing between the applications running on in-house data centers and external clouds. While such software exists, it is not yet ready for widespread use. As these products mature, companies should be able to plan for their internal data center capacities based on stable demand instead of peak numbers. Together with the broad adoption of virtualization, this trend could lead to drastic improvements in the utilization of data center resources.

Three reasons why CEOs should care about the cloud

To compete effectively in today's multi-polar world, CEOs need every edge they can get, from low cost to speed and employee productivity. As IT becomes a utility, it is now possible to focus more attention on using IT to create business value. CEOs may find that the cloud in particular can contribute to their agenda through the following three areas:

• Faster entry into new markets: One key advantage of the cloud is elasticity. By tapping into right cloud capabilities, companies can quickly enter new markets or launch new products or services in existing markets. As demand grows, they can quickly scale up. Conversely, when opportunities dry up, they can just as quickly scale down with minimum waste of time and capital.

• Faster and better innovations: CEOs increasingly recognize that the traditional closed innovation model is no longer adequate to keep up with the rapid pace of today's market. By using cloud-based solutions such as crowdsourcing, companies are able to open up innovation to more employees, customers, partners and even the public around the globe so that they can harvest better ideas faster.

• Improving worker productivity: To attract top talent and stay close to local markets, most companies must deal with a globally distributed workforce. Since cloud-based applications are inherently global and collaborative, they are essential in helping companies enable distributed teams to work together more effectively.

• **Public versus private clouds.** A common misperception about cloud computing is that, eventually, there will be only a handful of clouds, all of which are public. That is highly unlikely given the complex IT needs in large enterprises. While some general-purpose public clouds will exist, two other types of cloud are likely to emerge. One type, "specialty clouds," will cater to the particular needs of a select group of organizations, an industry or even a country. For example, a health care cloud based on a central or federated repository of electronic patient records (such as Microsoft HealthVault or Google Health) would bring together payers, providers, drug companies and health care consumers. Some large multinationals may opt to build and operate their own "private clouds" or "internal clouds" while continuing to tap into external cloud sources. That way, they could achieve both elasticity and control over service quality, data and other important variables.

Cloud computing will have significant impact on enterprise IT as it transforms to fulfill its role of enabling high performance within a rapidly changing business environment. With the unprecedented economies of scale and elasticity of the cloud, companies will no longer be limited by their in-house capabilities. Instead, IT will become a dynamic resource that adapts automatically to business demand. By relying on the standard Web platform, the cloud will also help improve collaboration, access and overall user experience. Business users will be able to buy, share, customize, and even create their own applications directly. Collectively, these capabilities will help reshape IT into a true utility that enables businesses to innovate faster and compete more effectively.

Just as the shift from isolated power generation to an electricity grid took several decades to make an impact nationwide, IT's migration into the cloud will take years. Significant uncertainties and challenges still lie ahead—both technological and organizational. What's interesting is that the ranks of the early adopters include many emerging-market enterprises.[10] Gaining access to the cloud may further add to the advantages these companies already have in cost and nimbleness.

[10] The Vietnamese government is among the first users of IBM cloud computing infrastructure. IBM's first Blue Cloud Center was built and went live in early 2008 in Wuxi City, China. Of the 13 such IBM cloud centers, eight are located in emerging countries, including China, India, Brazil, Vietnam, South Africa, and South Korea.

The message for large enterprises is stark. Although many leading businesses and government organizations are starting to experiment with the cloud, a more comprehensive approach should be considered. Unless they seriously consider making the cloud a part of their strategy, these companies may find themselves disadvantaged when competing in today's increasingly multi-polar marketplace.

About Accenture Technology Labs

Accenture Technology Labs, the dedicated technology research and development (R&D) organization within Accenture, has been turning technology innovation into business results for 20 years. The Labs create a vision of how technology will shape the future and invent the next wave of cutting-edge business solutions. Working closely with Accenture's global network of specialists, Accenture Technology Labs helps clients innovate to achieve high performance. The Labs are located in San Jose, California; Chicago, Illinois; Sophia Antipolis, France; and Bangalore, India. For more information, please visit our website at www.accenture.com/accenturetechlabs.

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