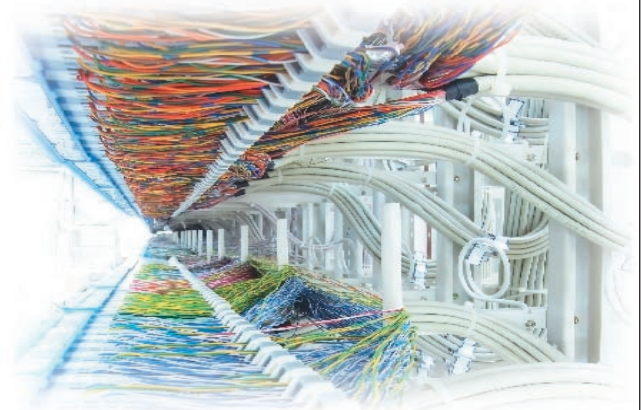


Is Cloud Computing Really Ready for Prime Time?

➔ Neal Leavitt



Even though the technology faces several significant challenges, many vendors and industry observers predict a bright future for cloud computing.

Cloud computing has become a significant technology trend, and many experts expect it to reshape information-technology processes and the IT marketplace during the next five years.

With the technology, users on various types of devices—including PCs, laptops, smart phones, and PDAs—access programs, storage, processing, and even application-development platforms over the Internet, via services offered by cloud-computing providers. Resources are kept on providers' servers, rather than on users' systems.

Proponents tout the technology's advantages, including cost savings, high availability, and easy scalability.

Industry observers say the technology's growth potential is enormous. Market-research firm IDC expects IT cloud-services spending to grow from about \$16 billion in 2008 to about \$42 billion by 2012, as Figure 1 shows. IDC also predicts cloud-computing spending will account for 25 percent of annual IT expenditure growth by 2012 and nearly a third of the growth the following year.

Working via large platforms owned

by providers and shared by numerous users makes cloud computing less expensive, according to proponents.

"The shift to cloud computing will dramatically reduce the cost of information technology," said Russ Daniels, Hewlett-Packard's vice president and chief technology officer for cloud-services strategy. "But it goes beyond cost savings. It frees customers from the expense and hassle of having to install and maintain applications locally."

Cloud computing also lowers the cost of application development and makes the process more scalable, noted analyst Simon Heron of Network Box, an Internet security firm.

Nonetheless, the approach is still relatively new and has not yet been widely adopted. IT departments are still wary of it because they don't control the cloud-computing platform.

So far, venture capitalists have not invested a lot of money in cloud-computing providers.

In addition, the approach has several important weaknesses that vendors must address before it can become more popular.

Carl Howe, director of the Anywhere Consumer Research Group for the Yankee Group, a market research

firm, said key risks include reliability, security, the additional cost of the necessary network bandwidth, and getting locked into specific cloud-computing vendors.

While proponents say it's only a matter of time before the technology overcomes these problems, others say the process might not be easy and could continue to hold back adoption.

COMPUTING IN THE CLOUD

Initially, companies utilized unused general-purpose data-center capacity to provide cloud-computing services.

However, major providers began creating separate cloud-computing business units and dedicated data centers to make sure the systems function optimally and maximize their revenue-generation potential.

Smaller providers, on the other hand, generally base their services in bigger companies' data centers.

Cloud computing's precursors include

- thin clients, which run applications and services housed elsewhere and accessed via a network;

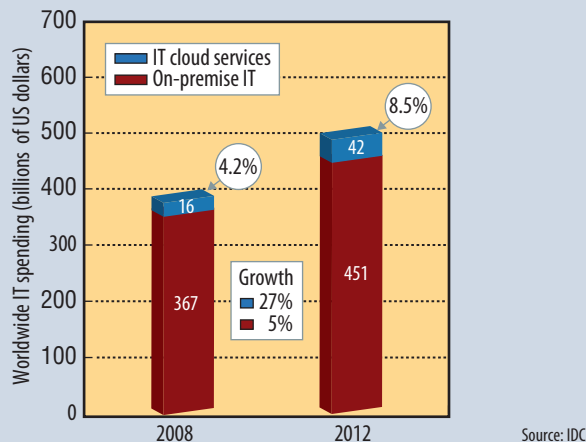


Figure 1. Industry observers say cloud computing has great commercial potential. Market-research firm IDC expects IT cloud services spending to grow from about \$16 billion in 2008 to about \$42 billion by 2012 and to increase its share of overall IT spending from 4.2 to 8.5 percent.

- grid computing, which links disparate computers to form one large infrastructure; and
- utility computing, a metered service in which individuals work with programs kept on shared servers rather than on individual PCs and, like a public utility, pay based on their usage level.

Major cloud-computing services include Amazon.com's Amazon Web Services, Google's Google Apps, and Salesforce.com's Force.com.

Microsoft's Windows Azure provides general cloud-based computing resources to users. The company also offers specific Internet-based applications such as Dynamics CRM Online for customer-relationship management, Exchange Online for messaging, Office Communications Online for instant messaging, and SharePoint Online for collaboration.

Other cloud providers include AppNexus, GoGrid, GridLayer, Mosso, and XCalibre Communications.

Cisco Systems and Oracle are working on the technology. And Hewlett-Packard, IBM, and Sun Microsystems have shown interest in providing cloud-computing ser-

vices or tools, according to James Staten, principal analyst at Forrester Research.

Under the hood

At their most basic, cloud-computing providers' infrastructures consist of Internet-connected servers, at one site or distributed across several locations, that house applications and data. They also include virtualization, grid, management, database, and other types of software; user interfaces; APIs; a communications infrastructure for connecting to users over the Internet or a private network; and a usage monitoring and billing mechanism.

Clients generally use browsers or dedicated software to access cloud applications, which they frequently control via APIs.

"Cloud-service infrastructures must be designed to host multiple tenants with high service levels over long periods of time," the Yankee Group's Howe said.

Grids, blades, virtualization. Some companies use grids of distributed servers or multiple blade servers run by a master controller to provide cloud-computing services.

And frequently, they also use vir-

tualization, noted GoGrid technology evangelist Michael Sheehan.

Virtualization lets a single PC or server simultaneously run multiple operating systems or multiple sessions of a single OS. Providers can thus run services for multiple customers on individual computers, rather than having to put each on a different machine. This uses the provider's resources efficiently and effectively separates the services for different customers.

It also enables easy scalability and the flexible creation and dismantling of resources that customers need only temporarily for special projects or peak workloads, said Jim Jones, a managing director with Scale Venture Partners, a venture capital firm.

Dynamic infrastructure software.

Most cloud systems employ infrastructure software that dynamically, rapidly, and efficiently scales as needed to meet customer demand with little, if any, intervention by service providers.

Control. Companies use an API or Web interface to control their cloud-based IT infrastructures, said GoGrid's Sheehan. Software developers use the APIs to control the systems programmatically.

Virtually all major cloud providers use APIs that have the structure of Web services standards such as SOAP, said IDC senior vice president and chief analyst Frank Gens. However, he noted, the APIs are still proprietary because they use the provider's own semantics within the standards' structures.

Implementation and billing. To implement cloud computing, organizations generally just have to set up a secure account with a provider. In some cases, they must also download additional software.

Providers bill users based on the number of minutes or hours they spend on a cloud system or on their level of consumption of resources such as bandwidth consumed, data transferred, or storage space filled.

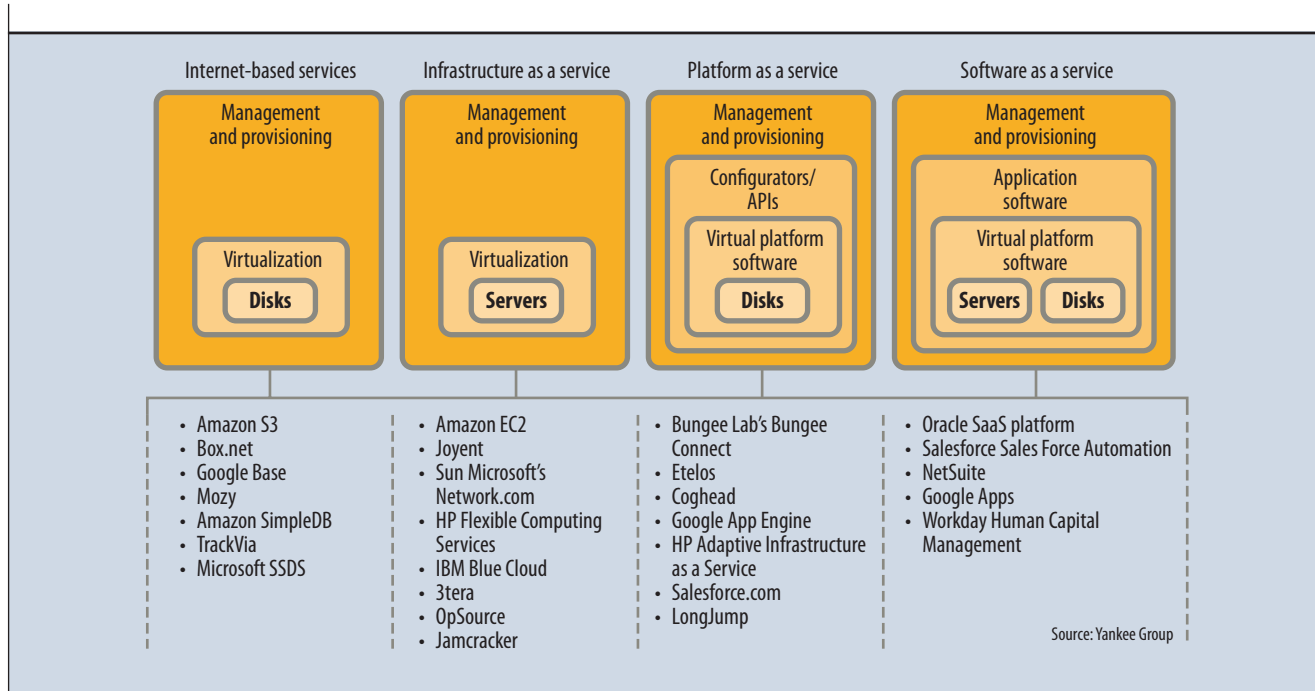


Figure 2. A number of vendors offer one or more of the four major types of cloud services.

Types of cloud services

There are four kinds of cloud services, as Figure 2 shows.

Services. Some products offer Internet-based services—such as storage, middleware, collaboration, and database capabilities—directly to users.

IaaS. Infrastructure-as-a-service products deliver a full computer infrastructure via the Internet

PaaS. Platform-as-a-service products offer a full or partial application development environment that users can access and utilize online, even in collaboration with others.

SaaS. Software-as-a-service products provide a complete, turnkey application—including complex programs such as those for CRM or enterprise-resource management via the Internet.

Advantages

Companies that run their own platforms must buy and maintain their own hardware and software infrastructures and hire staff to take care of the system, all of which can be expensive and time-consuming.

Cloud computing eliminates the need to do this.

Providing excess computing and storage capacity just to handle maximum workloads can be an inefficient use of resources. In fact, noted Forrester's Staten, "Most enterprise data centers are using less than 50 percent of the total capacity of their resources."

Availability. Cloud-computing proponents say a system run by a large service provider that has many resources and redundant equipment should offer more availability than an infrastructure run in-house by a small or even midsize company.

Application integration and support. Integrating multiple services and assets into a powerful composite application is more convenient with well-designed cloud platforms, said Salesforce.com director of platform research Peter Coffee.

The systems generally use SOAP, the Web Services Description Language (WSDL), and other nonproprietary Web service protocols, many XML-based. This enables easy interaction with and

support of legacy resources and other infrastructure services, he explained.

Flexibility. Most cloud-computing vendors don't require contracts and let users work with their services as needed. This makes cloud computing a good way to get the extra resources needed for activities such as testing new services or products.

Adopting the cloud

Most early cloud-computing adopters have been Web 2.0 companies and start-ups.

The ability to control costs and provision infrastructure as needed particularly appeals to new businesses with fewer resources, noted GoGrid's Sheehan.

Web 2.0 companies also traditionally have fewer resources and want the ability to easily ramp demand up or down as needed, he added.

Bigger companies, which generally wait to adopt new technologies, are using cloud computing for occasional or temporary projects that demand a lot of additional resources he said.

CHALLENGES ON THE HORIZON

More companies are starting to recognize and realize the benefits and advantages of cloud computing.

However, as with any emerging approach, there is some fear, uncertainty, and concern about the technology's maturity.

Potential users may be waiting until more organizations have experience with cloud computing and have developed best practices, said Forrester's Staten.

However, providers can change it when and how they see fit, without customers' consent, said John Pescatore, chief security analyst for market-research firm Gartner Inc.

Performance, latency, reliability

Performance concerns may stop some companies from using cloud computing for transaction-oriented and other data-intensive applications.

following standard security practices, which requires disclosure and inspection, said Staten. For example, users don't necessarily want providers to have multiple customers sharing the same virtual hardware and network resources.

Also, stated Howe, data stored in the cloud might be used anywhere in the world and thus might be subject to state or national data-storage laws related to privacy or record keeping.

Various governments, such as those in the European Union, have privacy regulations that prohibit the transmission of some types of personal data outside the EU, said Gens. "This has caused Amazon and other companies to develop offerings using storage facilities located in the EU," he noted.

Cloud computing is still relatively new and has not yet been widely adopted.

He added, "Cloud computing is maturing slowly, so the business case is slow in developing."

A sign that the technology may be beginning to mature is that vendors are starting to offer tools for managing cloud-based resources.

According to GoGrid's Sheehan, venture capitalists, who could fund providers and thereby kick-start cloud computing, are cautious right now with any emerging new business. Over time, he said, they may invest in cloud computing first with established companies and then via start-ups.

Control

IT departments are wary of cloud computing because an outside provider, not the organization's own staff, designs and controls the platform, said Rob Enderle, president and principal analyst of the Enderle Group, a market research firm.

The providers generally don't design platforms to support specific companies' IT and business practices.

Also, users can't change the platform's technology when they want.

Some providers, noted Network Box's Heron, temporarily run short of capacity—either by provisioning too many virtual machines or saturating their Internet links—in the face of high demand. This hurts their systems' performance until they can remedy the situation.

Customers who are a long distance from cloud providers could experience latency, particularly if there is a lot of traffic and their code is not optimized for efficient transmission.

Security and privacy

A recent survey of chief information officers and IT executives by IDC rated security as their main cloud-computing concern. Almost 75 percent of respondents said they were worried about security.

"With their businesses' information and critical IT resources outside the firewall, customers worry about their vulnerability to attack," said IDC's Gens.

This could limit cloud computing's desirability, said Gartner Fellow and vice president David Cearley.

Users want to be confident that their cloud-computing provider is

Related bandwidth costs

While companies can save money on equipment and software with cloud computing, they could incur higher network-bandwidth charges from their service providers, noted Howe.

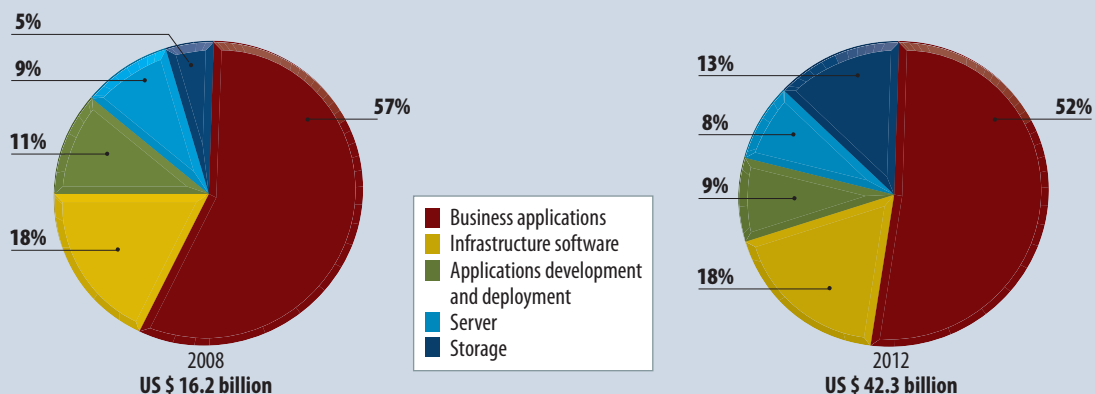
Bandwidth costs might be low for smaller Internet-based applications that aren't data-intensive but could be very high when, for example, a company makes a multiterabyte database available via cloud computing, he said.

Vendor lock-in and standards

There are no cloud-computing standards for elements and processes such as APIs, the storage of server images for disaster recovery, and data import and export.

This is currently hampering adoption by limiting the portability of data and applications between systems, said Sheehan. Portability will become increasingly important as more cloud providers emerge, he noted.

If a company is dissatisfied with one cloud-computing service—or if the vendor goes out of business—the firm cannot necessarily easily



Source: IDC

Figure 3. Market-research firm IDC predicts that cloud-computing revenue will not only increase during the next few years, but the way organizations use the technology will change.

and inexpensively transfer service to another provider or bring it back in-house.

Instead, the company would have to reformat its data and applications, and transfer them to a new provider, a potentially complex process. And if the company brings the service in-house, it would have to hire employees with the skill necessary to work with the technology.

Transparency

Companies cannot pass audits of their capabilities by prospective clients if they can't demonstrate who has access to their data and how they keep unauthorized personnel from retrieving information.

Cloud-computing vendors are addressing this concern by having third parties audit their systems in advance and by documenting procedures designed to address customers' data-security needs.

Reliability

Cloud computing hasn't always provided round-the-clock reliability.

For example, Salesforce.com left customers without service for six hours on 12 February 2008.

And Amazon's S3 (Simple Storage Service) and EC2 (Elastic Compute Cloud) services suffered a three-hour outage three days later.

While most vendors provide service credits for outages, said Howe, "those credits are cold comfort for sales opportunities missed and executives cut off from business information."

Other concerns

At some times and in some areas, Internet connections aren't fast or reliable enough yet for cloud computing to be dependable.

For example, broadband Internet connections aren't available in all places, such as those that are far from a telephone company central office or hub.

Also, there aren't enough major cloud-services providers yet, which reduces the level of customer choice and marketplace competition.

"And there are some infrastructures that simply cannot be translated or transferred into the cloud," said Sheehan. "High-end databases are better hosted within a dedicated, managed server environment."

WHAT'S AHEAD

Because cloud computing is relatively new, particularly for large companies, it promises to change and develop quickly.

Sheehan predicted there will be more providers, richer services, established standards, and best practices. He also said organizations will develop private clouds behind their

firewalls for use with employees, partners, and others.

In addition, IDC says users will work with cloud computing in different ways during the next few years, as Figure 3 shows.

Research

HP Labs, Intel, and Yahoo have launched the distributed Cloud Research Test Bed—with facilities in Asia, Europe, and North America—to develop innovations such as cloud-computing-specific chips.

HP's Daniels said they will conduct advanced research in areas such as intelligent infrastructure, dynamic cloud services, and scaling.

"A fundamental challenge is that the cloud depends on handling increasing demand by scaling out, doing more work simultaneously in parallel," he noted. "We know how to do that efficiently for some workloads, but it's generally quite challenging."

IBM Research has launched the Research Compute Cloud, an on-demand, globally accessible set of computing resources that support business processes. The resources are distributed across the company's eight worldwide labs.

IBM is also leading the Resources and Services Virtualization without

Barriers research initiative with 13 European partners to develop technologies that automate cloud systems' response to customers' fluctuating demand for resources. The European Union is funding the \$17 million effort.

Prospects

The current difficult economic climate will boost cloud computing's appeal, particularly to companies without a lot of money for infrastructure investment, predicted AppNexus chief technology officer Mike Nolet.

"The core competency for most companies is not designing and building IT architecture," said Nolet. "They don't want to deal with middle-of-the-night emergencies, vendor management, the procurement cycle, estimating future needs, hiring and managing large IT staffs, and everything else needed for in-house infrastructure. If clients can trust the uptime, speed, and security of a cloud, we can't see any reason not to use it."

In addition, corporate data-center managers are facing increasing problems with power consumption, space, and IT costs, noted Scale Venture Partners' Jones.

"Over the next five years, cloud-computing services will become

a solution for small and midsize companies to completely outsource their data-center infrastructure and for larger companies to have a way to get peak load capacity without building larger data centers internally," he said.

Experts say that it will become easier this year to move data from one cloud-computing system to another and that this will boost the technology's prospects.

Also, said Nolet, providers will develop ecosystems that will let companies in the same private network better communicate and share data via clouds, thereby reducing latency.

However, said Enderle, only the biggest providers will have platforms reliable enough to make cloud computing suitable for mission-critical tasks.

Craig Mathias, analyst with and founder of the Farpoint Group consultancy, said, "I'm bullish on the concept. It will be the preferred solution over time contingent upon the industry developing a viable set of standards. We also need to see more success stories."

According to Enderle, cloud computing is likely the way most companies will try to contain IT costs,

unless security concerns overwhelm the economic advantages.

"It will become the essential foundation for a greatly expanded IT industry by lowering the economic and technical barriers for millions of developers to bring new offerings to market, and for billions more customers to adopt those offerings," said IDC's Gens.

"It's likely that cloud computing is a type of deployment architecture that will be with us for a long time to come," said Forrester's Staten. "It is becoming a new member of the IT portfolio of services and choices."

A key will be whether cloud computing can overcome the challenges it currently faces. **■**

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More on Cloud Computing

Throughout 2009, Computer Society publications such as *IT Professional*, *Internet Computing*, and *Computing in Science and Engineering* will feature special issues on cloud computing. Visit www.computingnow.computer.org/edcal to learn more and to find information about how to contribute.

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