Cloud Computing: IT as a Service

Geng Lin, *IBM Alliance at Cisco Systems*
David Fu, *Microsoft*
Jinzy Zhu, *IBM*
Glenn Dasmalchi, *Cisco Systems*

Industry panelists at an IEEE Computer Society conference in Beijing look at the opportunities and challenges emerging from cloud computing and how their companies are addressing them.

Cloud computing has been a dominant IT news topic over the past year, yet an understanding of exactly what it is and its eventual industry impact—both realized and potential—is only gradually becoming clear. To help demystify the matter, the 2008 IEEE International Conference on Web Services (ICWS), held last September in Beijing, included a panel, "Cloud Computing and IT as a Service: Opportunities and Challenges." It featured presentations from three IT vendor giants—Microsoft, IBM, and Cisco—addressing industry perspectives and cloud computing initiatives.

Our panel drew a standing-room-only crowd of about 40 academic and industry professionals and turned into a lively forum discussion that ended after just two hours because the next scheduled session needed the room.

What Is Cloud Computing?

We began the panel with a broad introductory definition: cloud computing is a nascent business and technology concept with different meanings for different people.

- For *application and IT users*, it's IT as a service (ITaaS)—that is, delivery of computing, storage, and applications over the Internet from centralized data centers.
- For *Internet application developers*, it's an Internet-scale software development platform and runtime environment.
- For *infrastructure providers and administrators*, it's the massive, distributed data center infrastructure connected by IP networks.

We also presented a three-layer cloud architecture to illustrate this definition:

- top-layer applications delivered on demand in the software-as-a-service (SaaS) model,
- middleware providing application services and/or a platform-as-a-service (PaaS) runtime environment for cloud applications, and
- a flexible infrastructure of distributed data center services connected via Internet-style networking.

Figure 1 illustrates the architecture with example products for each layer.

The Opportunities

The traditional IT model requires business users to make a front-loaded investment in software and hardware as well as a life-cycle investment in professional staff to maintain servers and upgrade software. IT services in the cloud shift much of this expense to a pay-as-you-go model and so offer significant cost advantages. For example, Microsoft's hosted Exchange Online services provide anytime-anywhere, multiple-device access to email, calendars, and contacts for US$10 per user per month, and SharePoint Online collaboration services cost just $7.25 per user per month.

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Using cloud infrastructure services, companies can redirect resources to more long-term strategic business development. Cloud-based software and services subscriptions can handle security, archiving, and business continuity. Early cloud computing offerings, such as Amazon Elastic Compute Cloud (EC2)—appealed primarily to the consumer and small-medium business (SMB) space, where the benefits of not having to establish an IT infrastructure—let alone one that scales on demand—far outweigh any shortcomings.

But ITaaS is a highly disruptive concept for enterprise users, who have less to gain and more to lose by outsourcing IT. Cloud service providers trying to serve this space must implement enterprise-class capabilities at multiple levels both in the network and at the end points. Key business and technical challenges include cost, security, performance, business resiliency, interoperability, and data migration.

Cloud computing is still in early development. Market researchers, financial analysts, and business leaders all want to assess its potential markets and business impact. According to IDC, a market research firm that recently surveyed IT executives, CIOs, and other business leaders, IT spending on cloud services will reach US$42 billion by 2012 (http://blogs.idc.com/ie/?p=224). However, as with any disruptive technology and transitional business model, there is no definitive assessment of cloud computing's market opportunity. We believe its long-term business impact could be even larger.

Three Enterprise Strategies

As leading IT vendors, Microsoft, IBM, and Cisco are embracing cloud computing while experimenting with business models that strengthen their current customer base.

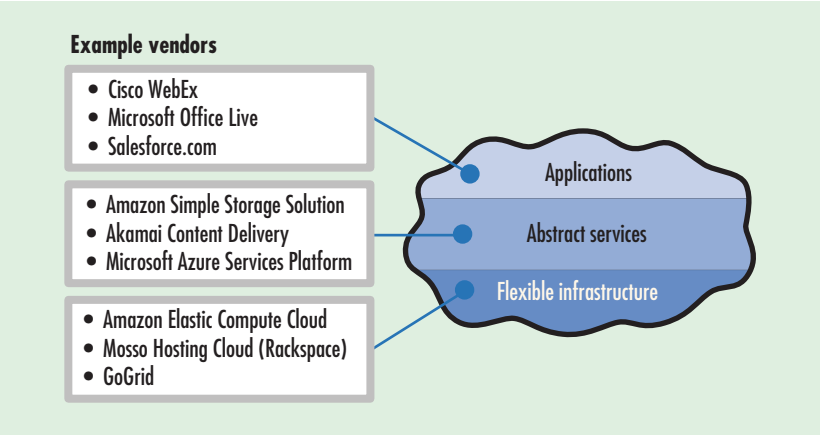

Figure 1. Three-layer cloud computing architecture. The callouts on the left list example products for each layer.

Microsoft: Software plus Services

Microsoft is building its cloud infrastructure to give current Windows and .NET users a seamless experience, whether they're deploying an application on site or delivering it as a service from the cloud. Microsoft's chief software architect Ray Ozzie coined the term "software plus services" to emphasize a strategy for enabling enterprise users to keep some applications on the ground.

Microsoft didn't formally announce the Azure Services Platform until a month after the ICWS conference, but the overall architecture and strategy had been in development under the codename Red Dog since 2007. The Azure platform is hosted in Microsoft data centers through Microsoft's Global Foundation Services, which correspond to the infrastructure layer in Figure 1. The platform's operating system, Windows Azure, provides a development, service-hosting, and service-management environment. The initial set of developer services includes Web application hosting in addition to the company's scalable storage for unstructured, structured, and queue data. Third-party developers don't have to use these services to create cloud applications, but Microsoft designed them to make it easier for millions of Microsoft developers worldwide to do their work.

Several Microsoft SaaS applications already run on the Azure platform, such as Live Mesh, HealthVault, and Events Online. Hewlett-Packard and several other companies are gearing up their development on the Azure platform as well.

IBM: Transformation through Customer Implementations

IBM launched its Blue Cloud initiative in November 2007 to help corporate data centers operate "more like the Internet." The company scored significant commercial successes in 2008, including Wuxi Software Park in China and iTricity in the Netherlands. These customers are leveraging Blue Cloud to build dynamic infrastructures that provide ITaaS to their end users.

The Blue Cloud was introduced as a way to connect and provision the proliferating array

Table 1. IBM comparison of traditional vs. automatic, cloud-based deployment times for eight IT management tasks.

IT management task	Traditional deployment	Automatic deployment
Assign servers	3 days	< 1 hour
Install software	5–10 days	< 1 hour
Configure network and security parameters	5–10 days	< 1 hour
Back up operating system	2 hours	1/2 hour
Recover operating system	2 hours	1 hour
Install operating system patch	2 hours	1 hour
Dynamically allocate computing resources	1 hour	2 minutes
Regulate operating system parameters for many services	10 minutes	1 minute
Total	**14–24 days**	**< 6 hours**

of end-user devices and sensors and to rapidly develop and deploy applications and services for delivery over networks. The IBM panel presentation included a slide comparing times for traditional deployments of eight IT management tasks to times for IBM's cloud computing automated deployments. Table 1 reproduces the comparison, showing a total reduction from 14–24 days to less than six hours.

As part of the commitment IBM has made to develop technologies that meet geographically specific business requirements, the company has built IBM Cloud Labs all over the world—serving both public organizations and private enterprises. It has also invested in academic initiatives to support research and foster next-generation Internet skills it sees as critical to cloud computing's future, particularly in parallel programming.

Cisco: Evolving Interoperability

Cisco sees virtualization and automation as the key enabling technologies of cloud computing. As both the internal cloud fabric and delivery mechanism to users, the network plays a central role in enabling clouds with the security, performance, flexibility, and other SLA (service-level agreement) capabilities that enterprise customers require. Virtualization-aware networking, 10GE, and unified fabric technologies are a few examples of a longer list of network-based technologies that will enable enterprise-class clouds to interoperate.

In addition, Cisco provides Web 2.0-based collaboration products. For example, it moved into the cloud applications layer in 2007 when it purchased WebEx, the world's largest videoconferencing service at that time. WebEx Connect is a subsequent cloud application that uses Cisco data center technology to let users share presentations, applications, documents, and desktops. It includes WebEx's full-motion video and integrated audio in a multimedia environment.

With respect to Cisco's focus on enabling enterprise-class clouds and cloud interoperability, Figure 2 shows the development state of five areas of cloud computing technology presented at the ICWS panel. Cisco sees three of those areas needing significant improvement to enable the cloud for enterprise customers:

- Security must better ensure data privacy and isolate network traffic through partitioning.
- Performance guarantees and SLA enablement in general must address latency and QoS (quality-of-service) issues.
- Interoperability requirements must support customer choice and additional agility—for example, in workload mobility.

As the IT industry works to solve these problems, cloud adoption will occur in phases: from the stand-alone clouds in place today, to enterprise-class clouds with enhanced security and SLA capability, and finally to full interoperability across cloud infrastructures—that is, the intercloud.

Cloud computing represents the confluence of technology and business developments in the Internet, Web services, computing systems, and applications that have evolved over the past few decades. In this sense, it can seem like nothing new. Moreover, it's in the early stages of development, operating in public and private cloud silos. In this sense, the problem of migrating data between clouds—both public and private—is probably the biggest obstacle to fully realizing its potential to revolutionize IT infrastructure.

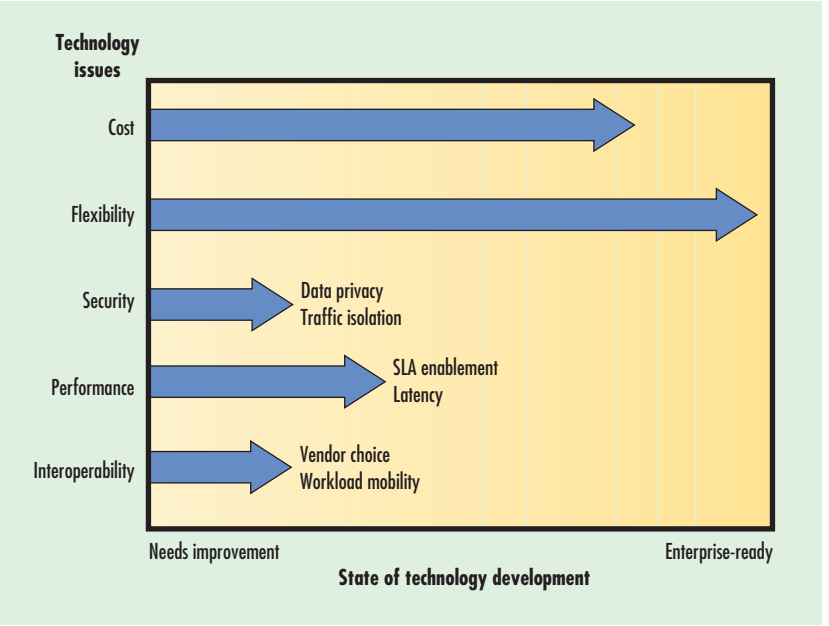

Figure 2. Enabling the cloud for the enterprise. Cost and flexibility benefits are enterprise-ready, but security, performance, and interoperability need significant improvement.

Meanwhile, many industry vendors and analysts are calling 2009 the year of cloud computing. Certainly, every major IT vendor has a strategy to capitalize on the cost and flexibility benefits of cloud computing, while addressing the issues that constrain its further deployment. The ICWS panel discussion saw standardization of cloud services and data definitions as necessary solutions to interoperability issues.

The discussion also revealed concerns about a few large public cloud operators asserting too much control over the Internet. This scenario could ultimately undo the Internet's fundamental open, decentralized design, which has fostered so much IT innovation. To the extent that IT becomes a huge utility, some of these issues might require appropriate government policies and regulations, such as those that are applied in today's telecom service provider industry.

Geng Lin *is chief technology officer for the IBM Alliance at Cisco Systems. Contact him at gelin@cisco.com.*

David Fu *is the principal engineering manager for Microsoft's Global Foundation Services. Contact him at davidfu@microsoft.com.*

Jinzy Zhu *is program director for the IBM Greater China Group's Cloud Labs and HiPODS (High Performance On-Demand Solutions) Asia Pacific program. Contact her at jinzy@us.ibm.com.*

Glenn Dasmalchi *is the technical chief of staff in the CTO Office at Cisco Systems. Contact him at gdasmalc@cisco.com.*