CLOUD-ENABLING THE ENTERPRISE

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MICHAEL KLIMENTIEV / FRANK STIENHANS / MOYA WATSON

Executive Summary SAP is not alone among large companies that are exploring cloud computing and its ramifications in and to enterprise software. Many enterprises are currently opting to invest in a hybrid approach that allows customers to provision enterprise software on on-demand infrastructures which are at the same time hosted on the premises. We refer to this on-demand /on-premises hybrid approach as ***cloud enabling***, with which the focus is on realizing all the benefits of cloud computing – including zero installation, automatic configuration, cost-savings, and immediate access in scalable data centers – while also preserving the benefits of on-premises hosting. In this paper, we talk about the current state of this research and development and its potential for enterprise products and service offerings in general.

This paper does not represent product announcements or commitments.

INTRODUCTION

In the technology industry, cloud computing means different things to different people. The concept of *the cloud* is often used as a metaphor for the Internet itself. More specifically, the term *cloud computing* has grown to popularity around the concept of developing, selling, and distributing software and related infrastructure as a service. In this sense, cloud computing means that instead of IT departments hosting data centers on the premises of companies themselves, this hosting is outsourced to third parties and made available via per-usage subscription fees that typically scale, along with the underlying infrastructure, with demand.

The benefits of cloud computing include zero installation, automatic configuration, cost-savings, and immediate access in scalable data centers, however many are concerned about potential risks involved with moving the control of infrastructure from the company premises to third parties.

There is hybrid approach, which allows for provisioning software on multiple on-demand infrastructures that are located both externally and internally (internally hosted infrastructures are known as "on-premises," often referred to as "on-premise"). We call this approach *cloud enabling*.

Market Overview

A complete market view of cloud computing frameworks involves different kinds of providers in at least four different domains:

- **Application providers** — also known as *software as a service (SaaS)*. Any Web application can be thought of as a cloud application in the sense that it resides on the Web, rather than on a local client. Well known examples include Google, Amazon, Facebook, and Twitter

- **Platform providers** — also known as *platform as a service*. In this case, the providers supply not only machine instances, but also higher-level APIs to help work with them. Key cloud platforms include Google AppEngine and Salesforce force.com

- **Infrastructure providers** — also known as *infrastructure as a service*. Vendors of cloud infrastructure typically offer computer infrastructure such as physical or virtual machine instances as a service, billed as if it were a utility (which is also referred to as *utility computing*). Amazon is currently the established leader in this domain

> *Web hosting is rapidly converging with cloud system infrastructure services. For the last several years, the market has been evolving toward on-demand infrastructure provisioned on a flexible, pay-as-you-go basis, but the introduction of cloud computing offerings has radically accelerated innovation in this market. The economic downturn has accelerated adoption of these offerings, thanks to the cost-savings that can be achieved by the move from physical to virtual services, and from purchasing for peak capacity to obtaining what you need only when you need it.*[1]

- **Service providers** — A fourth level is emerging in the form of consultant services that help build complete cloud solutions, such as Accenture and IBM

Amazon set the stage as the market leader by announcing services-based infrastructure when they introduced Amazon Web Services (AWS) in 2002. Key cloud computing services were introduced in 2006, including Elastic Compute Cloud (EC2), which provides scalable virtual servers as a service, and Simple Storage Service (S3), which provides service-based scalable application storage, and other relevant Web services. Amazon now represents the cloud infrastructure that has revolutionized the market and opened it up to radical new innovations across the application, platform, infrastructure, and service domains.

Different domains of cloud providers – and their consumers

These domains hold true for enterprise applications and other commercial applications running in the cloud in the same way that they do for popular Web 2.0 applications.

Large enterprises do and or can take advantage of cloud computing in many of these key domains, by actively participating as both an application provider and as an infrastructure provider. These companies typically have experience building internal tools and infrastructure in order to increase the efficiency of their own organizations. They can transform such internal tools into products in order to share that value with our customers and partners. They can leverage the experience with cloud computing in the same way.

Customer Challenges and Market Drivers

From a customer perspective, what challenges are driving the growth of cloud solutions in the market today? There are three main trends behind this: the industrialization of IT, advent of utility computing, and maturation of on-demand fulfillment.

Industrialization of IT
Information technology organizations regularly tackle complex processes in large organizations. There is significant incentive for IT to take manual, often complicated processes (such as that of procuring and configuring hardware across the employee base) and standardizing and automating them as much as possible. In this sense, cloud computing offers great promise with ease of procurement, and is a key driver in the transformation from manufacturing to automation and standardization of the IT business.

Utility Computing
In traditional server hosting, end-users often navigate inflexible and long-term contracts for this hardware. The trend of utility computing offers a solution to these issues, since you pay for only what you use or need, via metering of resource usage and payment based on this usage.

On-Demand Fulfillment
Rather than waiting for procuring necessary systems, the on-demand trend contains the promise of transforming long-running customer projects via immediate fulfillment of customer needs.

These three trends result in clear value. Development organizations can become more efficient and agile since software and hardware provisioning requires far less planning. In addition, cloud computing principles can result in massive cost reduction for large enterprises, customers, and partners in terms of IT and capital expenditures.

These principles also offer the possibility of development of innovative solutions not seen before, in which enterprise solutions can be consumed in an entirely new way.

The Cost Benefits of Cloud Scalability

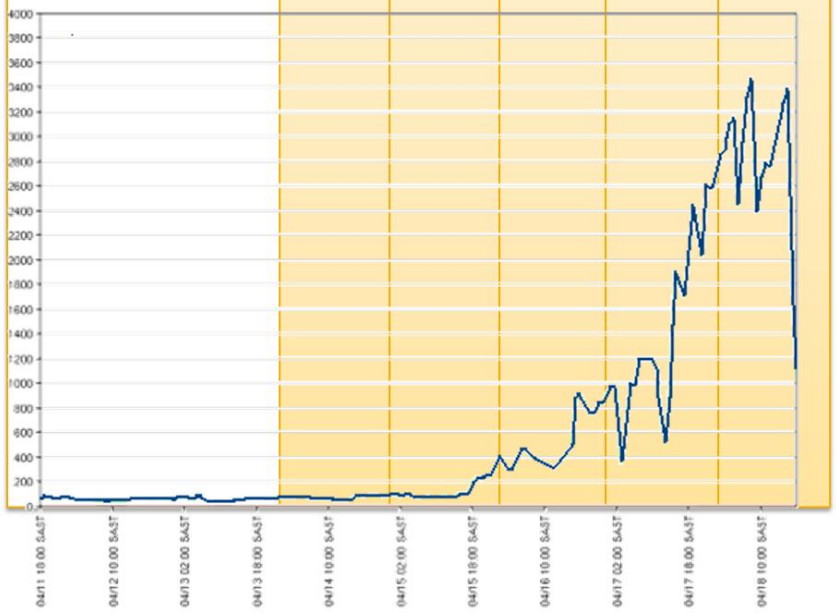
Cloud computing eliminates hardware idle time, and this is one of the key reasons why it works. To illustrate the cost benefits of cloud computing, let's consider a real-world example from an Amazon customer, the Web application Animoto.

Animoto is built on top of Amazon Web Services. In particular, they host their servers in the cloud, using Amazon EC2. On a typical day back in the beginning of April, 2008, their application required 50 instances of EC2 (50 servers). On April 14, they announced a new plug-in for Facebook, and their demand spiked exponentially, from 50 instances to up to 3,500 instances. Were they to try to accommodate that demand with their own hosting, they would have had to raise enough capital to buy and configure 3,450 additional

> *The biggest cost is not power, and it's not the servers, and it's not the people that maintain the data centers. The biggest cost is - is lack of utilization. It dominates all other costs.* [2]

servers – for a peak demand that might have only lasted a few days. Instead, Amazon EC2 scaled up to meet the demand, and scaled back down when the demand receded, as depicted in the graph below.

	Mon Apr 14th	Tue	Wed	Thu	Fri
Animoto Members	25,000	50,000			250,000
ec2 Server Instances	100	400	900	2800	3400



EC2 server instances scale to meet peak demand at Animoto

"You can see they've gone from 50 instances of EC2 usage up to 3,500 instances of EC2 usage. It's completely impractical in your own data center over the course of three days to scale from 50 servers to 3,500 servers. Don't try this at home." [3]

Not only does the EC2 business model lead to payment that is synchronous with user load, but the automatic, unattended scaling of the Animoto software architecture meant that they could service all customers properly during the peak load, which is critical especially for a small startup – and then release that load when it was no longer needed, also bypassing any provisioning time.

Considered another way, the smaller terms of billing for EC2 coupled with the low provisioning time lead to the following comparison with traditional hosting:

Term and Provisioning Time	Traditional Hosting	Amazon EC2
Minimum term	500 € / month	0.30 € / hour
Provisioning time	1 week minimum	6 minutes

When used 24/7, Amazon EC2 costs less than half that of traditional hosting. Additionally, the curve is linear, so that when used for days or hours at a time, costs drop dramatically to, for example, 15% those of traditional hosting for a typical work week.

As we've discussed, the cost savings are clear, but there are other benefits of investigating on-demand architecture within the large enterprise. On-demand architecture has the potential to serve the following business needs:

- Improve research and development efficiency
- Minimize cost of consuming enterprise software solutions (total cost of ownership)
- Fuel new product innovations, such as new service innovations

Sharing "perishable and intangible" computing power among multiple tenants can improve utilization rates, as servers are not unnecessarily left idle (which can reduce costs significantly while increasing the speed of application development). [4]

KEY CHALLENGES – AND SOLUTIONS

Now we discuss key challenges – and their potential solutions – of cloud enabling in the enterprise. Some challenges with cloud computing are very real, and some are perceived or a matter of education.

Some of the real challenges faced, such as governance and security of the infrastructure and lock-in danger, lead enterprises to naturally explore the hybrid cloud enabling approach of provisioning on-demand services via both on-premises and external infrastructures, which can provide a solution to many of the issues noted in this section.

- Lock-In Danger
- Security
- Data
- Service
- Legal

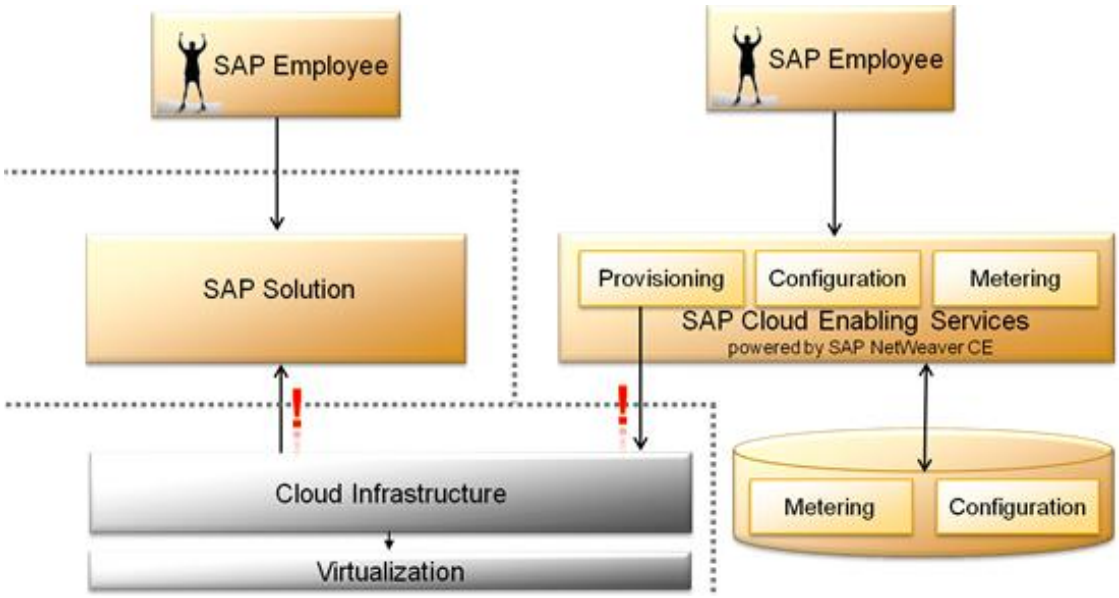
Lock-In Danger

Lock-in refers to different concepts ranging from the danger of "locking your data in" to an outsourced, third-party provider (and having trouble getting it back out), to developing for proprietary interfaces, to the idea that if the main computing and software power grows to become monopolized ("locked in") by a third party cloud, unless you belong to that third party, you no longer have the freedom to innovate with software or platforms. In each case, *lock-in* implies loss of control to a third-party vendor.

> *Standardization, of course, is a critical element to ~~c~~reating fluid markets for compute, development and application services in the cloud.*[5]

Today, there are private (internally hosted, on premises) and public cloud infrastructures dominating the trends. No single cloud infrastructure is currently ideal for all use cases, and each has a different service-level agreement, different kinds of integration, and different cost structures.

Significantly, every cloud infrastructure to-date bears proprietary elements in their interface, and to develop for one infrastructure creates a lock-in effect for that provider, as depicted in the graphic below.



Lock-In Danger

For any potential SAP cloud solutions, SAP, its customers, and our partners are interested in standardization of cloud APIs to mitigate this danger. Standardized cloud APIs should also allow for continued innovation with software solutions on the enterprise scale. To that end, SAP supports a concept called the *Open Cloud*, which "should support interoperability and portability across different cloud providers, using cloud services for infrastructure and management." [6]

Data Security

Perhaps the most common real and perceived challenge in cloud implementations is that of security. Since typical cloud hardware is not hosted on the premises inside the company firewall, many ask "We have very sensitive data; where is that system located? Is it secure? Who can access it?"

When people understand that the data is stored at a third-party provider, this often violates current software standards and suggests risk.

> *People tend to think differently about cloud applications when they host individual user data. The prospect of "my" data disappearing or being unavailable is far more alarming than, for example, the disappearance of a service that merely hosts an aggregated view of data that is available elsewhere.*[7]

Recently, a hacker guessed passwords of Twitter employees and in-turn compromised several sensitive documents that were stored conveniently in the cloud. Says Internet law professor Jonathan Zittrain: "Before, the bad guys usually needed

to get their hands on people's computers to see their secrets; in today's cloud all you need is a password." [8]

Although security risks are real, some of the challenge lies in education about security whether data is hosted on-site or off-site. Consider that no matter where the hardware you use to serve your applications is located, you still have the responsibility to configure your architecture properly to mitigate security risks. For example, it is possible to configure an internal image in such a way that it is accessible from outside of the company. To architect against risk in this case, typically enterprise IT hosting strongly discourages open access to the whole Internet, and it is preferable to provide a list of IP addresses or IP ranges to white-list.

We believe that there are no fundamental obstacles to making a cloud-computing environment as secure as the vast majority of in-house IT environments, and that many of the obstacles can be overcome immediately with well-understood technologies such as encrypted storage, Virtual Local Area Networks, and network middleboxes. [12]

Likewise, there are architectural approaches to systems design that can make cloud-stored data even more secure than typical behind-the-firewall instances. "Encrypting data before placing it in a Cloud may be even more secure than unencrypted data in a local data center,"[9] according to UC Berkeley engineers. Moreover, "In theory, cloud computing can be more secure than do-it-yourself computing since shared costs allow larger overall investment in security processes and infrastructure,"[10] says Dion Hinchcliffe on ZDNet.com.

Lastly, the a cloud enablement approach of hybrid on-premises and on-demand cloud solutions can mitigate this danger, since not all data is not stored externally in this scenario.

Data Transfer Bottlenecks

There is also the need for transport of large amounts of data. People wonder "Can we transport our code or data from an on-premises system to an ABAP cloud system?" Since you need both computers to see each other to move data between them, doesn't this also imply security risks, along with the challenge of moving the huge amounts of data? While it's relatively easy to allow an Amazon EC2 instance to see an enterprise-internal instance, it's more complicated the other way around.

Data transfer standards in the cloud are still emerging. UC Berkeley engineers maintain that one alternative to virtual data transfer is to ship disks, which they demonstrate is the cheapest and even fastest way to send large amounts of data, or even whole computers (they dub this "Netflix for Cloud Computing").[11]

Services

For company-hosted servers, such as those hosted inside of SAP by SAP Hosting or IT, your backup, security, failover, and scaling needs are typically taken care of by the company's in-house service. These services and governance typically don't exist in the cloud as a team behind your virtual server instance.

This results in on-site architecture around often proprietary cloud services (as mentioned previously in the context of lock-in). However, this too is an emergent space and we are witnessing growth in the domain of cloud service providers that will perhaps address this burgeoning need.

Legal Ramifications

Another common area of concern we have experienced while piloting cloud-based solutions is the area of legal ramifications. Teams ask about ownership, and whether they need to check with our company's legal department around uncertainties about licensing.

There are also real-world examples that indicate the legal scene is still evolving for publishers, providers, and end-users. For example, Amazon recently carried out a publisher's about-face on allowing George Orwell's 1984 e-book to be removed from Kindle readers. They removed it from the Kindle readers, after the e-book was purchased.

Methods are evolving for pay-for-use licensing, but the legal distinction of "ownership" in a service-based world is still playing out globally.

CURRENT APPLICATIONS – FUTURE DIRECTIONS

Currently, enterprise cloud-enabling is recommended for non-mission critical use cases, and can and does currently serve the following types of real-world scenarios in enterprises such as SAP:

- Development / Patching / Customizing
- Testing (Manual, Automated, Scalability)
- Training
- Demo / Workshops / Events
- Trial / Evaluation

Before clouds can run mission-critical landscapes such as the central human resources system, they need to mature in at least two domains:

- Tighter integration with on-premises IT: including network, operations, and billing
- Clearer service level agreements: addressing security, high availability, and performance

As we write this, these domains are evolving and such cloud infrastructures may be recommendable for mission-critical usage within a few years. However, it is important to understand that very often our customers spend more than half of their IT costs on non-mission critical systems, so the immediate use cases are clear.

Future potential of cloud computing in mission-critical applications includes domains such as:

- Disaster recovery
- On-premises – provisioning of productive landscapes
- On-demand – provisioning of productive services

CONCLUSION

Cloud computing is the present and the future, but in the present we need to be concerned with addressing its challenges as well as exploiting its benefits. Many of these challenges can be addressed with a hybrid approach of enterprise cloud enabling, which offers the promises of on-demand computing via a combination of on-premises and external cloud-based systems.

Benefits and Challenges

Cloud infrastructures are a clear trend in IT that increase business agility, decrease IT costs, and can allow consumption of existing solutions in new ways.

There is significant value in the domain of non-mission critical use cases today; in the future, once key challenges are addressed, we expect significant value in mission-critical use cases as well.

Key Benefits	Details
Scalability	■ Easy to grow or shrink physical servers to match demands
Instant access	■ Machines are available instantly
Cost savings	■ Save money by using machine CPU only when you need it

Key Challenges	Solutions and Opportunities
Lock-In Danger	■ Standardize APIs ■ Open Cloud Manifesto
Data Security	■ Architect for encryption, VLANs, firewalls ■ Education about security issues that are common regardless of internal or external hosting ■ Hybrid Enterprise Cloud Enabling
Data Transfer Bottlenecks	■ Ship physical disks overnight ■ Data backup/archival ■ Hybrid Enterprise Cloud Enabling
Services	■ Rely on multiple cloud providers ■ Rely on cloud consulting providers
Legal Ramifications	■ Pay-for-use licenses ■ Bulk-use sales ■ Hybrid Enterprise Cloud Enabling

Beyond Technology – A Future View

In addition to a hybrid cloud enabling approach for the enterprise, many solutions to key challenges of cloud computing will be solved in coming advances in technology. However, some advances will take more than technology – and may require legal and even political policy solutions. One of the areas that SAP participates actively in is in keeping the cloud open. Other areas are being actively tackled by Internet legal professionals.

Says Jonathan Zittrain, "Companies could be required under fair practices law to allow your data to be released back to you with just a click so that you can erase your digital footprints or simply take your business (and data) elsewhere." To increase security, "companies that keep their data in the cloud could adopt safer Internet communications and password practices, including the use of biometrics like fingerprints to validate identity." [14]

> *The most difficult challenge – both to grasp and to solve – of the cloud is its effect on our freedom to innovate… This freedom is at risk in the cloud, where the vendor of a platform has much more control over whether and how to let others write new software… The market is churning through these issues.* [13]

In conclusion, we've demonstrated great value at present in enterprise cloud computing solutions, and great promise exists in the future. Enterprises should be experimenting in accordance with the growth of the trends while working on addressing the challenges, such as with the hybrid approach of enterprise cloud enabling. Beyond SAP, we expect the market to "churn through the issues" and reveal innovations never-before-conceived in the years to come.

References

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- Cloud Computing at SAP Presentation – SAP UK TechTour; March 20, 2009

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[13] Ibid. Lost in the Cloud
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