Preface

Over the years, Cloud Computing has been one of the most popular topics in the IT industry and beyond. Cloud Computing is deemed the main trend of IT development for the coming decades, and it is to have a profound impact on the development of the human society and the world economy.

Cloud Computing is not only a technical terminology but also a marketing terminology that aims at providing computation, software, data access, and storage services, which do not require end-user knowledge of the physical location and configuration of the system that delivers these services. In other words, it is the delivery of computing as a service rather than a product, whereby widely shared resources, software, and information are provided on-demand.

It is becoming increasingly clear that we are moving from the era of personal computers to an exciting new era of personal computing. The integration of a wide range of devices, cloud services, and natural experiences that span the technology ecosystem and enable truly personal computing – nothing is to work in isolation, and everything is to work for the client.

Cloud Computing is not something that has suddenly appeared overnight: in some form it can be traced back to a time when computer systems remotely time-shared computing resources and applications. The lack of common understanding has been a big issue, as IT leaders try to reach a consensus on how to best approach Cloud Computing. In July 2009, the National Institute of Standards and Technology (NIST) released their first draft definition of Cloud Computing, and in October 2011, after sixteen rounds of revisions, they published the “final” definition in the NIST Special Publication 800-145. For the most part, the debate over the definition of Cloud Computing is over, at least for a period of time. Recently, Cloud Computing extended to cover applications, servers, as well as the network infrastructure and business solutions. Many companies, such as Microsoft, Google, Apple, IBM, Amazon, and Salesforce.com, have been delivering business from the cloud, and are starting to generate some revenues.

According to the official NIST (n.d.) definition: “Cloud Computing is a model for enabling ubiquitous, convenient on-demand network access to a shared pool of configurable computing resources, such as networks, servers, storage, applications and services, that can be rapidly provisioned and released, with minimal management effort or service provider interaction.” In short, Cloud Computing is described as a pool of abstracted, highly scalable, and managed computer infrastructures capable of hosting end-customer applications, and its clients can be billed by consumption.

Cloud Computing allows for the sharing and scalable deployment of services as needed from almost any location, and for which the customers can be billed based on their actual usage. Cloud Computing has a variety of characteristics: shared infrastructure, dynamic provisioning, network access, and managed metering.
SHARED INFRASTRUCTURE

Being in the “cloud” with virtualization technology, Cloud Computing enables the sharing of physical services, storage, and networking capabilities. The cloud infrastructure, regardless of deployment model, seeks to make the most of the available infrastructure for a number of users.

Shared infrastructure also makes Cloud Computing device and location independent. It enables the users to access systems using a Web browser regardless of their location or the device they are using.

DYNAMIC PROVISIONING

Scalability and elasticity via dynamic (i.e., “on-demand”) provisioning of resources are some important characteristics of Cloud Computing, which allows for the provision of services based on user requirements.

This is achieved automatically using software automation, enabling the expansion and contraction of service capabilities as needed. This dynamic scaling needs to be done while maintaining high levels of reliability and security.

NETWORK ACCESS

Cloud Computing requires broadband networks, including both wired and wireless, for a broad range of devices such as PCs, laptops, and mobile devices. Deployments of services in the cloud include everything from using business applications to the latest application on the newest smartphones.

MANAGED METERING

This characterizes Cloud Computing from the business point of view. Cloud Computing uses metering to manage and optimize services and provide reporting and billing information. In this way, consumers are billed for services according to the amount of computing resources they actually use during the billing period.

In general, each company can choose its cloud service and deployment model based on the specific business, operational, and technical requirements. The NIST have listed three service models of Cloud Computing: Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). Thereafter, IT companies and organizations have also introduced other service models such as Security a Service (SECaaS), Monitoring as a Service (MaaS), Communications as a Service (CaaS), and XaaS or “Anything as a Service.”

SOFTWARE AS A SERVICE (SaaS)

With SaaS, consumers can purchase the ability to access and use an application or service that is hosted in the cloud. Users do not have to install or maintain the SaaS application. Software is running on a cloud infrastructure belonging to the provider, and a user can access it via a Web browser.
The SaaS model can save companies costs on hardware, software, and maintenance. A benchmark example of this is Salesforce.com, where necessary information for the interactions between consumers and services are hosted as part of the services in the cloud. Microsoft is also expanding its involvement in this area, and as part of the Cloud Computing option for Microsoft® Office 2010, its Office Web Apps are available to Office volume licensing customers and Office Web App subscriptions, through Microsoft’s cloud-based Online Services.

**PLATFORM AS A SERVICE (PaaS)**

With PaaS, consumers purchase access to platforms, which enables them to deploy their own software and applications in the cloud. The operating systems and network access are managed by the provider instead of the consumer.

The PaaS services provide a great deal of flexibility, allowing companies to build their PaaS environments on demand with no capital expenditures, and enable companies to develop applications more quickly and efficiently in a cloud environment using the programming languages and tools supported by the provider.

**INFRASTRUCTURE AS A SERVICE (IaaS)**

With IaaS, consumers control and manage the systems in terms of the operating systems, applications, storage, and network connectivity, but they do not control the cloud infrastructure.

IaaS enables companies to deliver applications more efficiently by removing the complexities involved with managing their own infrastructure. IaaS enables fast deployment of applications and improves the agility of the IT services by instantly adding computing processing power and storage capacity when needed.

**OTHER CLOUD SERVICE MODELS**

SaaS, PaaS, and IaaS are the three primary service models of Cloud Computing, and there are other service models such as Security as a Service (SECaaS), Monitoring as a Service (MaaS), Communications as a Service (CaaS), and XaaS, or anything as a Service.

SECaaS is a business model in which a large service provider integrates their security services into a corporate infrastructure on a subscription basis. It is more cost effective than most individuals or corporations can provide on their own when the total cost of ownership is considered. These security services often include authentication, anti-virus, anti-malware/spyware, intrusion detection, security event management, and others.

MaaS provides an option to offload a large majority of monitoring costs by having it run as a service as opposed to fully invested in-house tools. So, for example, by logging onto a thin client or central Web-based dashboard, which is hosted by the service provider, the client can monitor the status of their key applications regardless of location.
CaaS is one subset of the model used to describe telephony services. It enables the client to utilize Enterprise-level VoIP, VPNs, PBX, and Unified Communications without the costly investment of purchasing, hosting, and managing the infrastructure by themselves.

Finally, XaaS, or Anything as a Service, is the delivery of IT as a service through hybrid Cloud Computing and is a reference to either one or a combination of SaaS, PaaS, IaaS, and so on. XaaS is quickly emerging as a term being readily recognized as services that have been previously separated on either private or public Clouds but are becoming increasingly more transparent and integrated.

Deploying Cloud Computing can differ depending on requirements. The NIST have also listed four primary deployment models—briefly discussed below—each with specific characteristics that support user demands.

**PRIVATE CLOUD**

The cloud infrastructure is deployed, maintained, and operated for a specific organization (such as a company, a university, or a government sector).

**COMMUNITY CLOUD**

The cloud infrastructure is shared among a number of organizations with a similar set of interests and requirements.

**PUBLIC CLOUD**

The cloud infrastructure is available to the public on a commercial basis by a cloud service provider. For example, Google online search is a public cloud service.

**HYBRID CLOUD**

The cloud infrastructure consists of a number of clouds of any type, and these clouds have the ability to move data and/or applications from one cloud to another through their interfaces. This can be a combination of private and public clouds, supporting the requirement to retain data in an organization and also the need to offer services in the cloud.

As discussed, Cloud Computing is about moving services, computation, and data offsite to an internal or external location-transparent and centralized facility or contractor. It makes data easily and ubiquitously accessible, often at much lower costs. It increases information value and enables opportunities for enhanced collaboration, integration, and analysis on a shared common platform.

Some of key benefits of Cloud Computing are:

- **Cost Savings:** Organizations are able to reduce their capital expenditures and use operational expenditures for increasing their computing capabilities. It provides a lower barrier of entry and also requires fewer in-house IT resources;
• **Scalability and Flexibility**: Cloud computing provides a smooth scalability path for organizations, which can start with a small deployment and grow to a large deployment fairly rapidly, and then quickly scale back if necessary. Cloud computing is also flexible enough to allow organizations to use extra resources at peak times, enabling them to satisfy fast-changing consumer demands;
• **Reliability**: Services using multiple redundant sites can support business continuity and disaster recovery;
• **Low Maintenance**: Cloud service providers perform the system maintenance, and access is through APIs that do not require application installations onto PCs, thus further reducing maintenance requirements;
• **Ubiquitously Accessible**: Mobile users enjoy increased productivity due to systems accessible in an infrastructure, available anywhere and anytime.

There are also some notable challenges associated with Cloud Computing. Most of them can provide opportunities if resolved with due care and attention in the planning stages. For example, some of well-known challenges include:

• **Security and Privacy**: The most challenging issues surrounding Cloud Computing are relate to storing and securing data and monitoring the use of the cloud by the service providers;
• **Lack of Standards**: Clouds have documented interfaces; however, no common standard exists with these clouds, and thus, most clouds are expected to have interoperability issues;
• **Continuously Evolving**: User requirements are continuously evolving, as are the requirements for interfaces, networking, and storage. This means that a “cloud,” especially a public one, does not remain static and is going to be continuously evolving;
• **Cloud Abuse**: With privately purchased hardware, crackers posing as legitimate customers can purchase the services of Cloud Computing for nefarious purposes. This includes password cracking and launching attacks using the purchased computing resources.

Through these challenges, several inevitable technology trends are going to be critical in driving the IT industry into a new cloud era, transforming the global technology scene, the enterprise sectors, and the society as a whole. They all serve the purpose of increased mobility, more social networking and interactions, the development of cloud computing, and the growth of big data. These are inter-dependent trends having an influence amongst themselves. Here, we would like to briefly touch on the three major trends:

• **Big Data**: Today, we are generating massive amounts of data, often called “big data.” At the same time, we are developing some exciting new ways to analyze data, which can help us see patterns or relationships that have been previously hidden. All these generate valuable insights. To tap into the latent value of big data, we need machine learning technologies that can learn from experience;
• **Natural User Interfaces**: Cloud computing, which encompasses voice, vision, gesture, multi-touch, and so on, is becoming more prevalent. Computing systems are gaining human-like perceptions, such as a better ability to see, hear, and understand. Combining this enhanced perception with big data and machine learning, these systems are beginning to understand our intent and context. This makes it possible for computers to really help us and even work on our behalf;
• **Blending of Two Worlds**: The digital world and the physical world are starting to blend together. The associated opportunities and means to collaborate are rapidly evolving, taking advantage of low-latency broadband networks and more natural computing interactions. When we blend the digital and physical realities together, we get something completely new. In the future, neither the human physical world nor the digital world will be sufficient all by itself.

As a result, we see more and more connected devices in a wider array of form factors changing the way we do business and conduct our lives. As the line between our work and personal lives blurs, people expect to apply the tools and advantages from one sphere to seamlessly blend with another. Therefore, we see new social tools in the workplace connecting colleagues and customers, as well as family and friends, all on whatever device we use at that time. Our users expect this. This of course is being enabled and accelerated by Cloud Computing, with its advantages of always-on connectivity and instant scalability, meaning that new apps and services are not only possible but have attractive economics. As these apps and services proliferate, so does the information that they capture and use, and this creates exponential growth of data, which is an enormous opportunity for deriving better insights for businesses and society.

Cloud Computing can creatively empower traditional businesses. The current economic climate is encouraging the IT departments to evaluate Cloud Computing as a clear path to cost reduction. Nearly everyone that consumes Cloud Computing is to enjoy cheaper alternatives to the on premise models. Although Cloud Computing can surely help reduce operating costs, the real promise of the cloud lies in its ability to help us fashion what we call the “real-time enterprise” – one that demands faster application development, a constant stream of data, and a responsiveness to business needs that is just not achievable with planning and refresh cycles being dragged out for years. Thus, the shift to Cloud Computing is not just a shift in the way storage is handled, or where computing tasks take place, it is a shift in the fundamental ways in which applications are designed and delivered. These “cloud-designed” applications require more than a simple collection of cloud-based services.

These trends are also fueling more advanced developments in e-commerce. Consumers expect to have device-specific experiences with applications, multiple-form factors, switching from a desktop PC and a browser to a slate type device and to smart phones. Consumers expect their experiences to be consistent but modify themselves contextually in an appropriate way. What we are finding out is that the buying experience is becoming more and more device centered, and the channel to reaching through to these market places is also where we deliver our first-party products. The destination is really an integrated buying experience on whatever device the consumers carry, and once they buy something, they want to know that it is going to transition and flow to all the other experiences they have. These are some very dramatic changes that all come back to this notion that the people have multiple devices, and the devices and people are more socially connected and/or interconnected, thus significantly changing the way we do commerce.

Cloud computing is opening new opportunities for entrepreneurs and innovators. It is revolutionary for startups and small businesses. Such companies typically have very little money for capital expenditures, and the cloud provides an affordable model that enables these companies to pay-as-they-go. The cloud offers opportunities to fuel entrepreneurship, job creation, and new venture creations by giving small-and-medium-sized enterprises easily scalable automated business processes and advantages. This enables more entrepreneurs to be able to easily translate their ideas into reality and enjoy their full potential building the next global business.
We need to also pay attend to Cloud Computing in emerging markets, especially in China – the center of gravity in the world not only economically but also in terms of innovation. Our world is shifting from what we call “the West”—North America, Europe, and a few other places—to “the East,” and China accounts for a huge share of this shift. With an existing strong talent base, the leading market for PCs, servers, mobile devices, and Internet users, the possibility for cloud development, with positive impacts on China’s economic growth, represents a significant area of opportunity. China’s leaders are well aware of all of the challenges before them and believe very strongly that to spur investment in innovation and technology is the clear path to successfully overcoming these challenges. China as a nation has five-year planning stages, and we are now in the 12th iteration. In that plan, China is committed to changing its model of economic growth toward a more innovation-driven economy, growing strategic industries including IT, and improving lives through sustainability, along with a number of other different initiatives. The government has explicitly embraced the cloud in their national policies, seeing it as a new area for economic growth, and they have already taken the steps to encourage the development of Cloud Computing in China.

Our book gives a comprehensive high-level overview of Cloud Computing, data management and security, data storage and big data, and some of the latest research results in networking aimed at satisfying the network demands in the cloud era. Finally, in the Appendix we discuss the development of cloud computing in China, which covers strategies that are most suitable for the Chinese society and culture.

With our book, we hope to help familiarize the readers with some key concepts of cloud computing, the available cloud technologies in the areas of big data and data security, communication networks, and also to become well aware of the direction of the IT development in the world. In this, we hope to help them in terms of making better informed short term and long term IT decisions for their enterprises and organizations.

Finally and most apparently, the information world is entering a new era, which is both driven by and enabled by Cloud Computing. Let’s be well prepared to embrace this new era!

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REFERENCES