Case Study: Deployment of Amazon Web Services to Fuel innovation in Multimedia Applications

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Abstract

Multimedia applications and services are dramatically emerging along with the increasing usage of rich-media content over the Internet. Both sustaining and disruptive innovation become more and more important for media companies in order to maintain its market competitiveness and provide high quality customized products that meet with their consumers' expectations. Achieving these challenges can't be done through the traditional fixed infrastructure, adopting for cloud computing technology is required to achieve scalability and flexibility. This case study tends to investigate the impact of adoption and the barriers of deploying Amazon Web Services as one of the widely used cloud-based services in media companies.

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1.0 INTRODUCTION

Multimedia services and applications have emerged in the last few years to provide rich-media-based services and content, including photos, videos, documents, and audio through the Internet with increasing quality in order to meet with the desired consumer quality of experience (QoE) and users' expectations to be provided with more customizable applications (Hands, 2009). Adopting in-house infrastructure becomes inefficient no longer an efficient choice for media companies to compete in the market through both sustaining and disruptive innovation (Bruce & Bessant, 2002).

Cloud computing is considered one of the emerging technologies that aims to deliver computing resources such as storage, bandwidth, and memory through the Internet. Hands (2009) indicated that along with the emerging information age, companies are taking further steps in the virtual world. In cloud computing, instead of adopting local infrastructure as fixed cost, companies subscribe to cloud services that can deliver resources based on three main models: 1) infrastructure as a service (IaaS) such as storage and memory, 2) platform as a service (PaaS) such as operating systems, and 3) software as a service (SaaS) such as web-based applications.

The scalability and flexibly paradigm of cloud computing can contribute in achieving innovation. This case study tends to investigate the impact of adopting one of the major cloud computing service, Amazon Web Services (AWS), in multimedia application design in order to achieve innovation based on design factors of competitiveness and technical and productive usage of Amazon AWS. Additionally, the case study tends to investigate the barriers that face adopting Amazon AWS services in terms of security and environmental impact.

2.0 MEDIA COMPANIES AND INNOVATION CHALLENGE

The last few years have seen dramatically increased usage of multimedia services and applications, which is aligned with the increasing usage of Internet over computers and mobile devices (Zhu, Luo, Wang, & Li, 2011). Media companies are now required to adopt high

technologies and infrastructure in order to serve their consumers with a competing quality. Furthermore, innovation becomes as essential factor for companies the exist and compete in the market (Bruce & Bessant, 2002), yet innovation management should clearly address the design opportunities in the future (Hollins, 2000). Another challenge face companies are the future focus on customized products rather than the generic one. This shift puts an end to the old "one-size-fits-all" model, as the future of design is moving away from generic products and toward more unique and customized services and products to fit the needs of both companies and consumers (Hands, 2009).

Meeting the above challenges can't be addressed with the traditional in-house infrastructure as it requires more scalable and flexible paradigm such as the cloud computing technology that allow companies to access software, infrastructure, platforms through the cloud without installing local infrastructure. Major companies such as Amazon, Google, IBM, and Microsoft. Delivering multimedia services and applications requires choosing the cloud vender that can serve media companies with a wide range of services that can be adopted in the product development process.

3.0 AMAZON AND CLOUD COMPUTING

Amazon's large infrastructure, scalability, and reliable business allowed the company to expand their business strategy to offer a cloud computing service on a large scale, allowing its consumers to access virtual resources such as hardware, software, and services as needed through pay-as-you-go plans (Shon, Cho, Han & Choi, 2014). In 2006, Amazon started to offer its Amazon Web Services (AWS) based on the cloud computing principles. While the current AWS includes more than 50 cloud services, it started with a cloud storage service, Simple Storage Service (S3). AWS and its services, including the Amazon S3, have since expanded in both infrastructure and functions provided, providing the opportunity for an increased consumer base. The total number of files stored in the Amazon S3 increased from 2.9 billion in 2006 to reach more than 2 trillion files in 2012. These files were stored on 454,400 servers with an ability to support several millions of virtual machines (Golden, 2013).

4.0 IMPACT OF ADOPTING AMAZON AWS

Companies working in multimedia services and application are faced with challenges related to infrastructure, consumers, and market competitiveness. With the increasing media quality for Internet speed, consumers expect to be provided with high-quality media files and to be able to use services and applications quickly and reliably, which is recognized as quality of service (QoS) (Liu, Li, & Yang, 2015).

4.1 Competitiveness through Innovation

In order to successfully compete in the emerging technology market, companies need to consider the competitiveness factors in the application and service design process (Bruce & Bessant, 2002). Walsh et al. (1988) categorized the factors of competitiveness that should be considered in the design process into price-related and non-price-related factors as follows (Cooper, & Press, 2002):

- **Price-related factors** include reducing the manufacturing costs and determining the cost of use and maintenance, which should reflect on the application price and life-cycle costs. In multimedia applications, limited or zero life-cycle costs are applied to the purchased products, as consumers pay for the service or product either once or based on subscription.
- **Non-price-related factors** include consumer expectations such as application performance, appearance (application user interface in digital products and services), reliability, safety (security in digital products), durability (stability in digital products), ease of use, ease of development, and the ability to meet delivery schedules and improve the ease of service and repair. This reflects on the design process on product specifications, company image, delivery time, and after-sales services such as customer support. Some of the factors proposed by Walsh et al. may not apply to media services and applications, such as packaging.

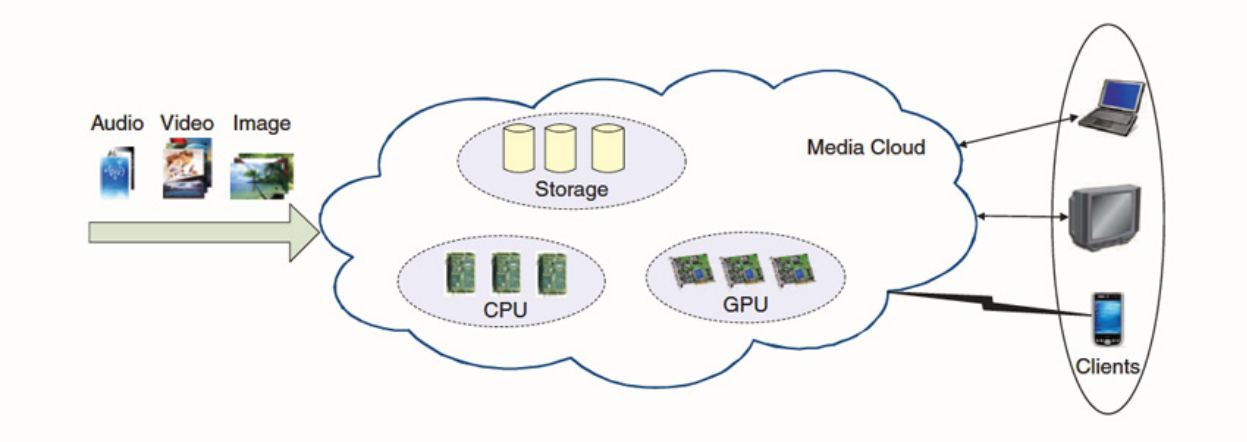

Figure 1. The cloud computing technology structure (Zhu, Luo, Wang, & Li, 2011).

Considering the above factors in the application design process requires companies to relay on a holistic cloud service such as Amazon AWS, which contribute helping companies to achieve the above factors. For example, adopting Amazon cloud service reduces the manufacturing costs as companies no longer need to buy and install in-house infrastructure. Instead, they deploy Amazon cloud services and pay for only what they use. Another non-price-related factor is the ease of development as companies directly use one of Amazon cloud services and adopt it into production without the need to develop it from scratch.

4.2 Technicality and Productivity

Another challenge face multimedia companies related to the technical resources required to achieve technology innovation such as delivering new services or building new applications. Technical resources can be categorized into infrastructure, software, and developing platforms as following:

4.2.1 Infrastructure

The increase of multimedia applications and service reflects on the number of files and resources shared over the Internet, this increasing process for media content has significantly increased the amount of multimedia computing and resources infrastructure required to handle those requests (Zhu, Luo, Wang, & Li, 2011), and subsequently requires an expandable infrastructure that includes servers, networking, disk storage, and memory, in addition to the administration service

(Kavis, 2014). This paradigm presents a challenge for multimedia companies due to the frequently updated media quality, formats, and sizes. Hands (2009) suggested that the future of design is moving toward virtual organization structure.

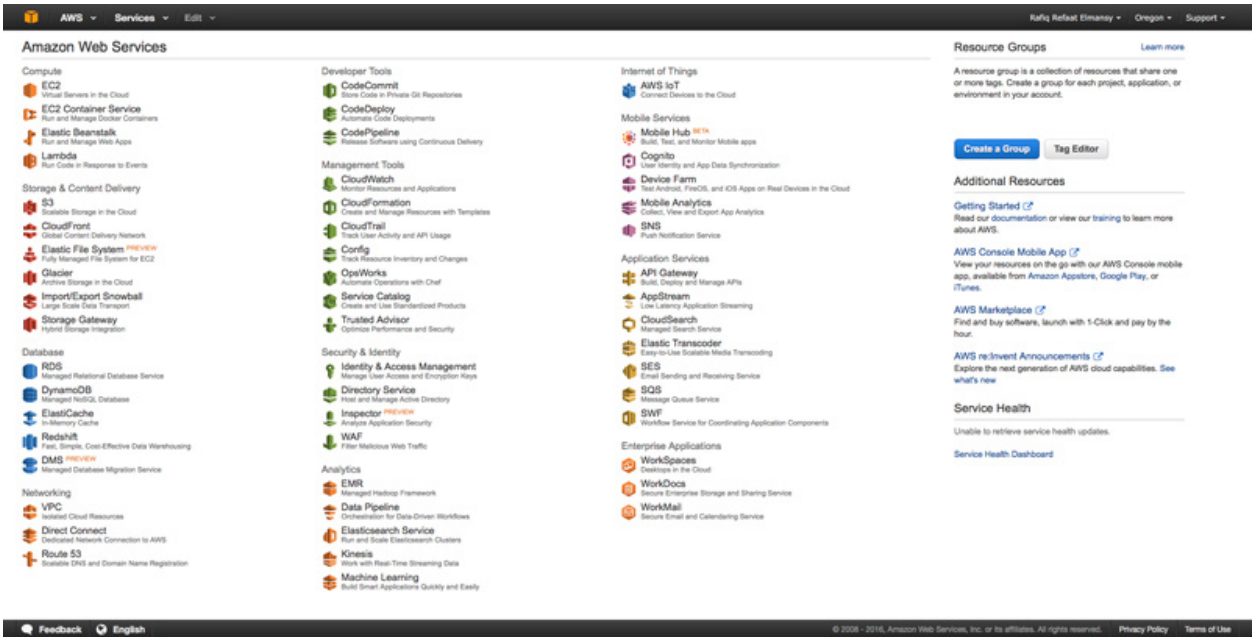

Figure 2. Amazon AWS web-based interface

Amazon AWS provides a large range of services under the IaaS model that can be adopted in multimedia application design and development. The Infrastructure as a Service (IaaS) cloud model tends to provide infrastructure service to consumers per request, which reduces the cost of infrastructure installation and administration from the consumer side (Hwang, Dongarra, & Fox, 2013). Examples of Amazon AWS that can be adopted in multimedia production include the following:

- **Amazon EC2**

  Amazon EC2 can be also adopted in multimedia production to reduce the transcoding cost along with Amazon Elastic Transcoder. Transcoding is a process implemented in video streaming, where video is converted from one compression format to another to be adjusted based on the client device, bandwidth, and operating system. This technique is achieved through using a private cloud infrastructure and then using additional instances

as needed. For example, if a number of videos are uploaded for transcoding, they are added to free instances in the cloud; if the number of videos is more than the free instance capacity, new instances start to transcode the extra videos in parallel, and once the queue is empty, these extra instances are released (Kovachev, Cao, & Klamma, 2014).

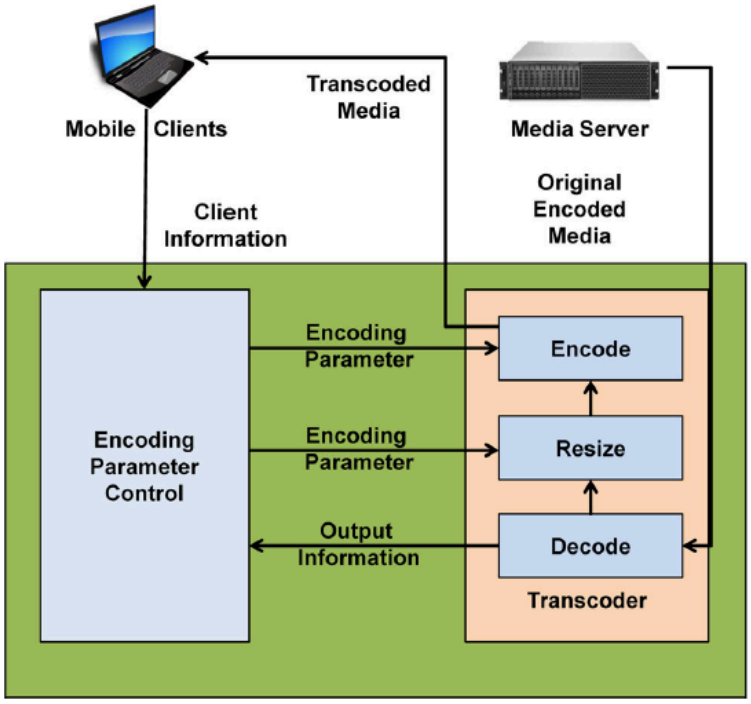

Figure 3. Architecture of a legacy transcoding system (Kim, M., et al., 2014).

- **Amazon S3**

  Amazon Simple Storage System (S3) runs under the EC2 to store an unlimited number of objects (Marinescu, 2013). Companies to store large files such as images and videos on Amazon virtual machines using S3 service and only pay for the currently consumed storage size. As a result, storage resources consumption dedicated to saving and transferring these files from the companies' original servers to clients are reduced, which reflects on the service delivery speed and reliability.

- **Amazon CloudFront**

  Amazon CloudFront provides content delivery network (CDN) services, which is an

infrastructure that represents group of servers used to facilitate the delivery of information and media files generated by media websites to the client quickly and in an efficient format (Held, 2010). CloudFront can be integrated with other AWS services such as Amazon S3 to distribute content to consumers at a low cost and high transfer speed for media, while paying for only the consumed bandwidth without minimum usage commitments (Amazon, 2016).

4.2.2 Developing Platform

In the Platform as a Service (PaaS) model, platform and developing environment is provided to the cloud consumers for deployment and integration with the application development process. This platform can be an operating system or web-based development platform (Rountree & Castrillo, 2013). While Amazon Web Services is initially based not the IaaS model, some services such as the Amazon Elastic Beanstalk can be considered a PaaS model because they provide a development environment for developers to upload and deploy their application programmed with different languages.

5.0 BARRIERS OF DEPLOYING AMAZON AWS

The barriers that face companies to adopt Amazon AWS services are more related to the cloud computing technology than Amazon as a service provider. These barriers are related to security and data access from one side and sustainability and environmental impact from another as below:

5.1 Security

One of the major challenges facing the future deployment of cloud computing in multimedia applications and service have to do with security-related issues, especially when working with critical and sensitive consumer data and sharing it over the Internet. In the traditional in-house infrastructure, companies have full control over the security process to adopt their own networks security measurements (Furht, & Escalante, 2010). These security issues can be categorized into the following:

- **IaaS Security Issues**

Amazon AWS offers the security level for both the vendor and hypervisor that only affects physical security. However, the consumer is responsible for IT system security control related to operating systems, applications, and data. While the implementation of cloud computing tends to reduce infrastructure costs, the security procedures from the company's side present a drawback, as investments should be dedicated for infrastructure training administrators and license security software (Subashini, & Kavitha, 2011).

- **Data Security**

  Consumer data, such as payment information, payment, information, photos, videos, and others, should be especially secured when shared through the Internet. The security threat increases as the data is shared with cloud services that are not fully controlled inside the company. Cloud computing services vary in the data security level even inside one service like the Amazon AWS. For example, while the Amazon EC2 offers data security, as administrators don't have direct access to consumer instances such as virtual machines due to the data encryption, Amazon S3 data is not encrypted by default, and consumers need to encrypt their data before uploading to the Amazon S3 storage to secure it from being accessed by unauthorized parties (Subashini, & Kavitha, 2011).

- **Network Security**

  In addition to the data security over the cloud infrastructure, data flow over the network and between vendors should be secured in order to prevent network-based attacks such as Man-In-The-Middle (MITM) attacks and IP spoofing. Encrypted endpoints are deployed in Amazon cloud services such as the EC2 and S3 to ensure safe data flow over the network. However, weaknesses in the network security configuration can be exploited by users, especially in active sessions to gain access to user data, media, and critical information.

5.2 Sustainability and Environmental Impact

Present and future products should pay more attention to the environmental impact of the design process as well as the opportunities that can be triggered through the deployment of the sustainable design principles in different production stages (Bruce, & Bessant, 2002). On the other hand, consumers are forcing companies to review the current standards and practices, as they are increasingly concerned about the environmental impact of their own lives (Hands,

2009). While digital products tend to be more sustainable due to the reduced usage of raw materials and less pollution emissions, another environmental issue can be identified due to the massive usage of energy. Accenture (2010) indicated that moving to the cloud resources contributed to reduced Carbon emissions with different percentages. For example, small businesses moving to cloud services contributed to reducing the carbon footprint for the companies with a percentage up to 90 percent, while large companies reduced between 30 to 60 percent of their carbon emissions (Golden, 2013).

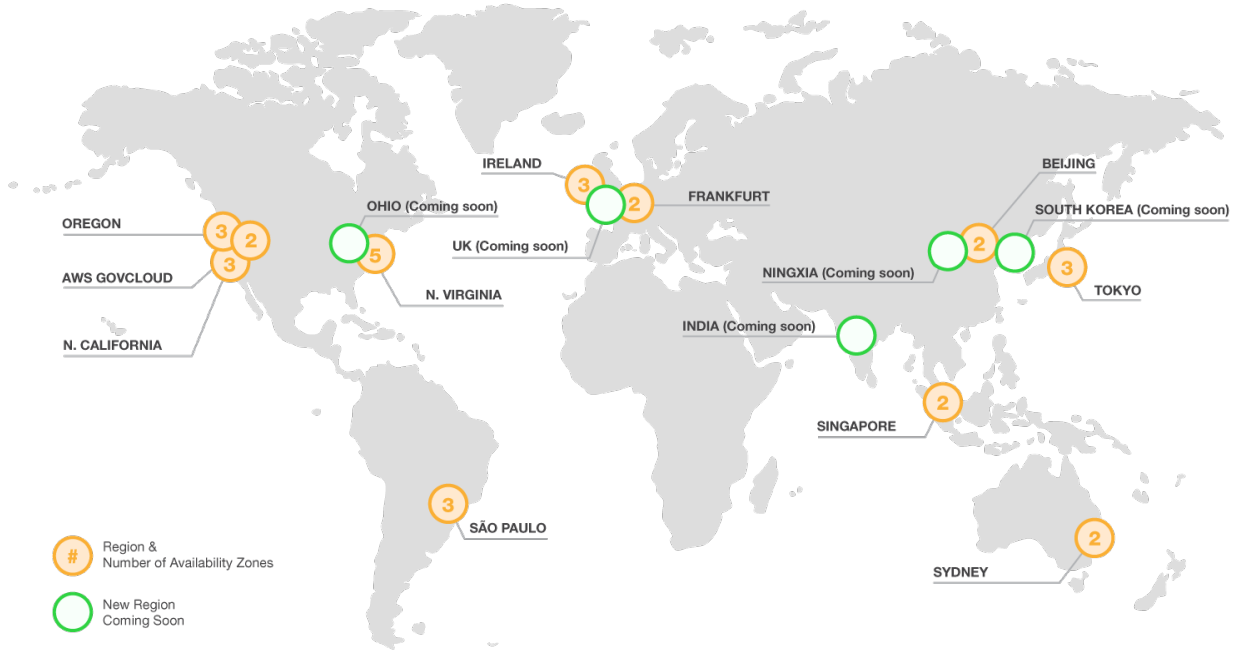

Figure 4. Amazon AWS data centers around the world (Micah, 2015)

Although cloud computing contributed to reducing the locally installed infrastructure (Liu, Li, & Yang, 2015), the frequently increasing number of servers and computing processes results in a significant impact on the energy consumption by server grids. Amazon AWS, for example, requires 454,400 servers in order to operate different services. According to a 2007 report published by the U.S. Environmental Protection Agency (EPA), data entered in the United States consumed 1.5 percent of the total national power, which costs around $4.5 billon with a total carbon emission of 80 to 116 metric megatons per year (Golden, 2013). However, a number of features and procedures could be adopted by cloud computing companies such as Amazon in order to support sustainability and turn datacenters toward greener computing. These features,

which were lighted by Accenture (2010), include:

- **Dynamic provisioning**, which allows applications to automatically move from lower capacity servers to higher capacity servers when needed only.
- **Multi-tenancy**, which allows SaaS service providers to serve different companies on the same infrastructure and software to reduce the energy and Carbon emissions associated with it.
- **Server utilization**, which hosts multiple applications on the same server, isolated from each other in order to reduce the amount of active servers.
- **Datacenter efficiency**, which refers to the adoption of state-of-art datacenters that use energy efficient technologies to reduce overall energy consumption.

6.0 CONCLUSION

Media companies are now required to innovate more than before in order to meet with the market competency and meet with their consumer expectations. This can't be achieved through the fixed infrastructure paradigm. Therefore, cloud computing technology can help companies to overcome many of the fixed infrastructure obstacles and move to more scalable and flexible paradigm. Deploying cloud-based service such as Amazon AWS has direct impact on the company's ability to innovation. This impact incudes increasing the ability to address design factors for competitiveness, and adopt more flexible and less expensive technologies and platforms. On the other hand, deployment of Amazon AWS technology is faced with barriers that are shared with most of the cloud computing services such as the security concerns and environmental impact. While companies should move to the cloud service as a contributor for innovation cloud vendors should address security and data centers sustainability issues.

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