A CLOUD BASED FRAMEWORK FOR AUTOMATED CAD DESIGN

Georgios Andreadis[1], Athanasios Drossos[2]

[1]Aristotle University of Thessaloniki, Department of Mechanical Engineering
54124, Thessaloniki, Greece
[2] Agiou Georgiou 50, Pyrgos Hleias, 27100, Greece

Corresponding author: Georgios Andreadis, andreadi@eng.auth.gr

Abstract: In this paper we have summarized the current developments in relation to cloud computing, and cloud implementation in CAD systems. In particular using the ability for customization of CAD Systems by the AutoLISP programming language, we propose an architecture for automation of design via cloud computing. In addition we tried to answer the quintessential question: should a constructional company migrate the design process to the cloud? We also discuss issues regarding i) security and privacy politics on the cloud and ii) the Quality of Services (QoS) , which are crucial for the cloud computing. We study a system that exploits the cloud computing paradigm to realize a scalable CAD service for designing lifts. In this context we present and dissect the architecture and discuss several issues. The system is designed with the principle of reducing the cloud size (cost) while maintaining reasonable QoS.
Key words: CAD, CAM, Design, Cloud, Web

1. INTRODUCTION TO CLOUD COMPUTING

According to National institute of Standards and Technology "Cloud Computing is a model for enabling convenient, on demand network access to a shared pool of configurable computing resources (e.g. networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort of service provider interaction"
Customers pay only for the used computer resources and services by means of customized service level agreement, as well as have no knowledge of how a service provider uses an underlying computer technological infrastructure to support them.
In Cloud Computing everything is treated as service.
SaaS: Software as a Service
PaaS: Platform as a Service
IaaS: Infrastructure as a Service
Software as Service: Some times referred to as Application as a service (AaaS). It is a software delivery model which allows the consumers to use service providers' applications over the network. SaaS model are based on multi-tenant architecture, where a single versions of the application, with a single configuration (Hardware, network, operating system) is used for all customers. SaaS is typically accessed by users, using thin client via a web browser.
Examples of the key providers are the Google Apps, Microsoft Office Live Small Business, IBM (Blue Cloud), CMiC etc.
Platform as a Service: Cloud platform as a service, allows consumers to deploy applications on to provider platform. Consumers do not have to manage or control infrastructure including network servers, operating system s or storages, but has control over the deployed applications.
In the Providers of PaaS Includes, Saleforce App exchange, Google App Engine, Amazon etc.
Infrastructure as a Service: Cloud Infrastructure as service is also referred as Hardware as a service. In this cloud service model, cloud providers offer computers, as physical or more often as virtual machines, and other resources. The Virtual Machines are run as guests by hypervisor such as Xen on KVM. Management of hypervisor by the cloud operational support system leads to the ability to scale support a large number of Virtual machines. This service is extremely useful for enterprise users as it eliminates the need for investing in building and managing their own IT Systems.
GoCrid and Amazon EC2 are some of the pioneer IaaS providers.

2. CLOUD SECURITY AND PRIVACY

Security is an essential component of strong privacy safeguards in all online computing environments, but security alone is not sufficient. Consumers and businesses are willing to use online computing only if they trust that their data will remain private and secure. The ability of cloud computing providers go live up to these expectations is critical not only for the future of cloud computing but also for protecting

fundamental rights of privacy and freedom of expression.
An organization's security posture is characterized by the Confidentiality, Integrity Availability, Authenticity, Authorization, Authentication and Non - Repudiation. These controls are implemented in one or more layers ranging from the facilities (Physical security), to the network infrastructure (network security), to the IT systems (system security), all the way to the information and applications (application security).
To adopt cloud computing it is necessary to ensure clients and providers security measures:
Client side security: Web browsers are majorly used I client side to access cloud computing services. Cloud providers usually provide the consumers with APIs whish is used by latter to control, monitor the cloud services. It is vital to ensure the security of these APIs to protect against both accidental and malicious attempts to evade the security
Provider's security: A secure infrastructure ensures and builds confidence that the data stored is secure in provider's side to adopt cloud computing it is necessary to ensure providers security measures. To enhance the trust factor providers can get their system verified by external organizations or by security auditors Traditional data centers used to have regular security audit and mandatory security certifications which ensure the data security. Cloud providers should also incorporate these measures to assure secure transaction among its customers
As described earlier in this document, the security responsibilities of both the provider and the consumer greatly differ between cloud service models. Amazon's AWS EC2 infrastructure as a service offering, as an example, include vendor responsibility for security up to this hypervisor, meaning they can only address security controls such as physical security, environmental security, and virtualization security. The consumer, in turn, is responsible for security controls that relate to the IT system including the operating system, applications, and data. On the other hand Salesforce.com is not only responsible for the physical and environmental security controls, but it must also address the security controls on the infrastructure, the applications, and the data.
Another confront of cloud computing is the privacy breach. In case of privacy infringement due to providers fault, the confusion still exist on who will take the responsibility and will compensate to the affected people. Lack of common security standards also adds to the concern of data storage over cloud.
The data security Lifecycle consists of seven phases:
Generation: Classify, Assign Rights
Use: Rights Management, Logical Controls, Application Security
Transfer, Transformation: Encryption, Logical Controls, Application Security
Storage: Access Controls, Encryption Rights Management, Content Discovery
Archival: Encryption, Asset Management
Destruction: Crypto-Shredding, Secure Deletion, Content Discovery

3. SERVICE PERFORMANCE AND ANALYSIS IN CLOUD COMPUTING

As referred above cloud computing ensure scalable resources such as files, data programs, hardware and third party services accessible from a Web browser via internet to users. These customers pay only for the used computer resources and services by means of customized service level agreement (SLA). A metric which a customer is in general concerned and should be defined in SLA, is the response time. More specifically a customer is more inclined to request a statistical bound on its response time than an average response time. By considering this percentile of response time metric, K. Xiong and H.Perros study the relationship among the maximal number of customers, the minimal service resources and the highest level of services, [1]. Specifically studied three questions: 1) For given service resources what level of QoS can be guaranteed; 2) For a given number of customers, how many service resources are required to ensure that customer services can be guaranteed in term of percentile of response time; 3) For given service resources, how many customers can be supported to ensure that customer services can be guaranteed in term of percentile of response time;
For answering the above three questions, the writers have first proposed a queuing network model, for studying the performance of computer services in cloud computing, and then developed an approximation method for computing the Laplace transform of a response time distribution in the cloud computing system.
The proposed method provides an efficient and accurate solution for the calculation of probability and cumulative distributions of the response time, and the maximal number of customers for given computer service resources in cloud computing in which customer services can be guaranteed in the term of the percentile of response time. It will be useful in the services performance prediction of cloud computing

4. ENTERPRISES ON THE CLOUD

There will be many ways in which the cloud will change businesses and the economy, most of them hard to predict, but one of them is already emerging. Businesses are becoming more like the technology itself: more adaptable, more interwoven and more specialized. These developments may not be new, but cloud computing will speed them, [2].

Yet the impact of the cloud will also be felt on the macroeconomic level. Just as it makes small firms more competitive, more modular and flexible, it will help developing economies to move ahead. Also companies will increasingly focus on their "core" improving their productive.

Reasons for an IT enterprise to move on the cloud or avoid it are:

Strengths: Availability (Response Time); Timely and consistent updates; Extremely fast scaling out; Pay as use (Reduction of capital and operating costs); Best personnel management (Personnel can focus more on producing value and innovation for the business).

Weaknesses: Lock on (it may be difficult to move it to another cloud provider); Data protection; An enterprise may pay services whish are not useful for it.

5. CASE STUDY

In this section we present an application of cloud computing using the Amazon's platform. In 2006 Amazon started offering a computing utility called Amazon Web Services (AWS).Anybody with credit card can start, a virtual machine on Amazon's computer system to run an application. Developers can quickly add extra machines when needed and shut them down if there is no demand (Which is why the utility is called Elastic Computing Cloud or EC2)

6. CONNECTION TO AMAZON EC2

The main characteristics are:

- Users can rent Amazon Machine Images (AMIs) on an hourly basis;
  - Provided an online catalog, a web interface and APIs;
- Users can publish AMIs to the Cloud;
- To start an image, the user configures:
  - Resources: processing, memory, IO performance;
  - Region: US West, Europe, Singapore, Tokyo;
  - Inbound firewall;
  - Credentials.
- When an AMI is initiated
  - Hostname is announced
    e.g. ec2 –IP-region.computer.amazonaws.com
- Accessible via SSH (port 22) or Remote Desktop (port 3389);
- User has root privileges, needs to administer system.

7. USING A CAD SYSTEM VIA THE CLOUD

In this paragraph we present a case study (fig.1, fig.2) using cloud computing for a CAD system in attempts to reduce the infrastructure cost, automate the design process, and minimize the human error, for a company specialized in design and construction interior stairs. CAD systems are used today in every product design and construction process, because of the ability for further customization and easily managed and distributed product information. Today a team of engineering has to be employed for calculating, studying and designing stairs, responding to the sales men demands. So the human errors and the time response are not negligible. In aim to improve the manufacturing cost of the final product we proposed an automated system, which customizes and designs a product automatically.

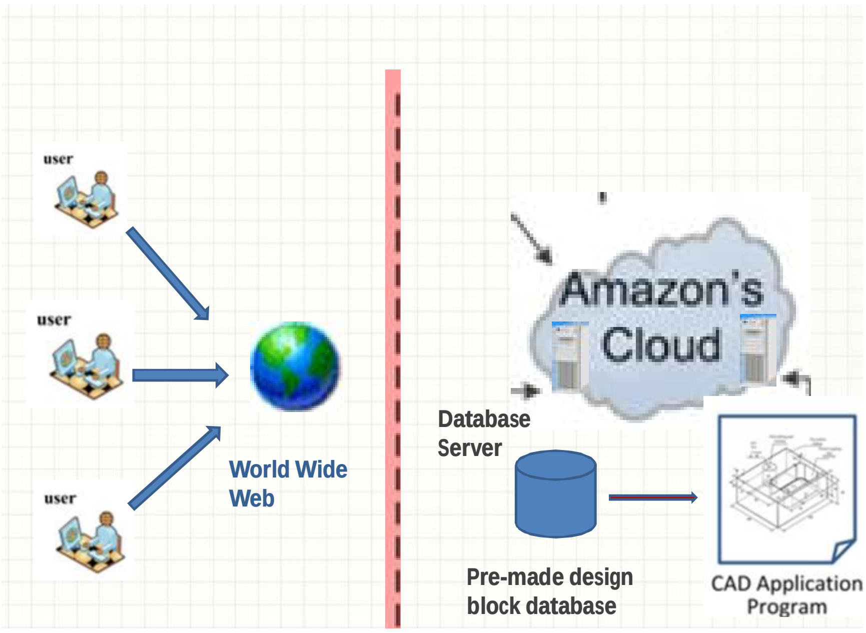

Fig.1 Framework of a cloud computing Platform

For the implementation of this system the following characteristics are needed:

1. Motivation company's CAD system on the Cloud.
2. Configuration of the CAD system using the script scenario ability.

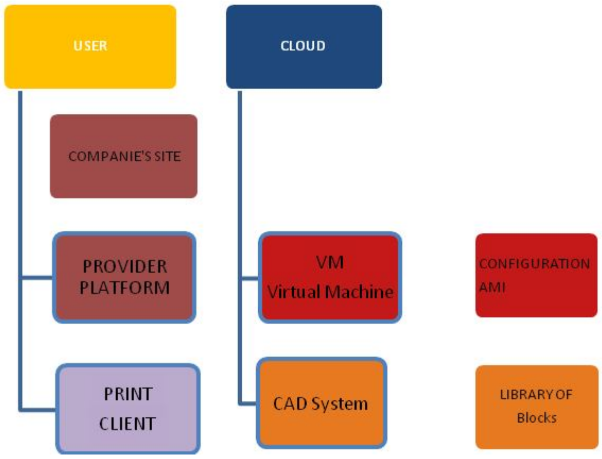

Fig. 2 System Architecture

System Architecture

The basic entities of the system include:

● Insertion: A user can insert on the provider cloud platform via the company's site

● Blocks: We draw the first step of the stairs and save it as Block which injected when it needed

● VM (Virtual Machines): VM is responsible for designing stairs according to the insertion parameters. In particular, a VM consists of a CAD application (AutoCAD in our case) that according the parameters designs the actual document using the API of the CAD.

● CAD System: we choose to use AutoCAD because it offers Lisp programming environment. So using Auto LISP programming language, ADS and Object ARX we can customize the design process.

8. CLOUD COMPUTING COST

In this section we study the cloud computing cost and we try to answer to the question: should we migrate our applications to the cloud? This question is challenging to answer due to the following reasons. Although any potential benefits of migrating to the cloud can be enumerated, some benefits may not apply to our application. There are several aspects to

this basic question that must be considered, [3, 4, 5, 6, 7, 8, 9].

So executives need to look closely into the costs of cloud computing for them. Hardware, after all, is a relatively small component of data center costs. They need to uncover the hidden management, transition, and usage cost that reveal themselves only when a companies start to work with the technology. They need to look into the costs of using each kind of cloud service separately, since this pricing and cost involved in using different kinds of cloud services all vary. Only then they can reliably estimate the savings Gray has employed this concept in his work [3], as we can see in Table 1. Gray calculated what 1$ bought in 2003. Table 1 shows his numbers vs 2008 and compares to Amazon cloud EC2/S3 charges. For example we can say costs $2.56 to rent $1 worth of CPU. But if we estimate the power we can say, buying 128 hours of CPU in 2008 really costs $2 rather than $1, compared to $2.56 on EC2. Similarly, 10 GB of disk space costs $2 rather than $1, compared to $1.20-$1.50 per month on S3. While we employ the same concept, we go beyond this work i) compare in house cost and cloud cost in relation of hardware base (Number of servers) ii) we study the impact of system utilization.

Table 1. Comparison of costs between cloud computing and 'local computing'

	WAN bandwidth/mo.	CPU hours (all cores)	Disk storage
Item in 2003	1Mbps WAN link	2 GHz CPU, 2 GB DRAM	200 GB disk, 50 Mb/s transfer rate
Cost in 2003	$100/mo.	$2000	$200
$1 buys in 2003	1 GB	8 CPU hours	1 GB
Item in 2008	100 Mbps WAN link	2 GHz, 2 sockets, 4 cores/socket, 4 GB DRAM	1 TB disk, 115 MB/s sustained transfer
Cost in 2008	$3600/mo.	$1000	$100
$1 buys in 2008	2.7 GB	128 CPU hours	10 GB
Cost/Performance improvement	2.7x	16x	10x
Cost to rent $1 worth on AWS in 2008	**$0.27-$0.40** ($0.10-$0.15/GB x 3 GB)	**$2.56** (128 x 2 VM's@$0.10 each)	**$1.20-$1.50** ($0.12-$0.15/GB-month x 10 GB)

For a simplified example, we assume that the size of a company is represented by the number of servers which are used. So according to the number of servers, companies are classified as this table shows:

Number of services	*Class*
until 100	Small
101 – 2000	Medium
2001 – 10000	Large
10001 -50000	Extra Large

In this example we assume a company specialized in designing using CAD systems. We identify initial key factors affecting the costs of deployment choice (In house - cloud)

In House Cost

Hardware (Servers) cost   Number of users
Investment capital cost (Capital interest)
Maintenance cost
Decrease value of server cost

We consider 6 classes of companies' sizes including, 10, 100, 500, 1200, 2001, 5000 servers.

We used Amazon's cloud charges for a large EC2 system with the following technical specifications: CPU: 4EC2 Computer Units, RAM: 7.5 GB, Disk: 850 GB

The columns of Table 2 are:

1. Company class;
2. Number of servers;
3. System utilization (Hours / per day);
4. Worth of servers;
5. Power, cooling and physical plant cost;
6. Total cost for fully in- house services (4+5 columns);
7. Cost of gradual reduction of the servers value (which reflects the gradual diffusion and adoption of the new technology);
8. Monthly charges for fully cloud services by Amazon Class.

Table 2. Cloud cost comparison relative to company's size

1	2	3	4	5	6	7	8
A	10	4 3 2	4000X10 = 40.000$	40.000 $	80.000$	833 $	580,85 $ 440,28 $ 299,98 $
A	100	4 3 2	4000X100 = 400.000$	400.000$	800.000$	8333.3 $	5833,88 $ 4430,88 $ 3027,88 $
B	500	4 3 2	3,000X500 = 1.500.000$	1.500.000$	3.000.000$	31,250 $	29181,88 $ 22166,88 $ 15151,88 $
B	1200	4 3 2	3,000X1200 = 3.600.000$	3.600.000$	7.200.000$	75,000 $	70040,88 $ 53204,88 $ 36368,88 $
C	2001	4 3 2	2,500X2001 = 5,002.500$	5,002.500$	10.005.000$	104,218 $	116795,25 $ 88721,22 $ 60647,19 $
C	5000	4 3 2	2,500X5000 = 12.500.000$	12.500.000$	25.000.000$	260,416 $	291846,88 $ 221696,88 $ 151546,88 $

Our cost comparisons require us to make a number of assumptions:

1. The cost of a server matching the above specifications is 4000 $.For buying more than 500 servers the cost each of them is 3000$.
2. The costs of power, cooling and physical plant cost according to Hamilton estimation are equivalent to cost of server.
3. We will proceed to renewal of servers after 8 years

As we can see by comparison of columns 6 & 8 the cloud based options is cost-effective for small to medium (class A, B) companies, whereas in house option for large (class C) companies. Also the exact results depend on the utilization. For small workloads, the servers procured for in house provisioning end up having significantly more capacity than needed (and they remain under-utilized). On the other hand, cloud can offer instances matching the small workload needs.

Figure 3 illustrates the effect time utilization (hours/day) on the cloud cost. For time utilization 2 hours/day and 3 hours /day the cloud cost is became lower to in –house cost for all classes companies. For time utilization 4 hours/day the cloud cost rises for C class.

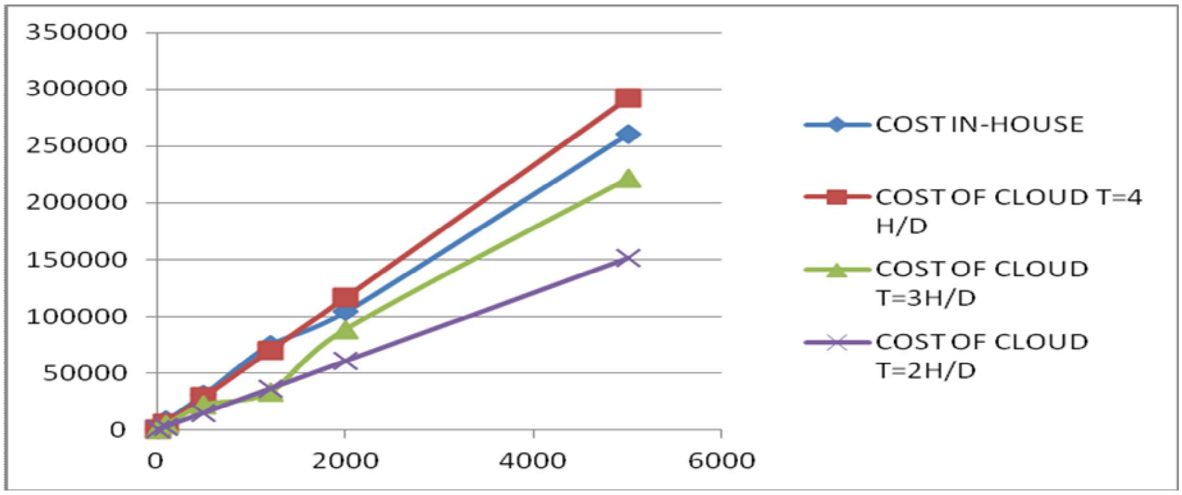

Fig.3. Effect of Time Utilization Variance

9. CONCLUSION

This paper has summarized the current developments in relation to cloud computing, and cloud implementation in CAD systems. The use of CAD systems via the cloud can solve some of the pressing needs of construction firms. Examples of automation design process via cad and cloud system have been presented. Also in this study we have investigated the migration cost for a construction company to cloud and how it is affected by the computing resources and utilization time. Some additional issues related to cloud have also addressed (QoS, and security & privacy politics in the cloud).

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