جامعة الملك فهد للبترول و المعادن
King Fahd University of Petroleum & Minerals

Cloud computing and GIS

(Term paper)

Delivered to: Dr. Baqer M. Al-Ramadan

Submitted by:

Ahmed Mansoor Al-Ameri

ID#201102190

Date: May 21, 2012

ABSTRACT

Geographic information systems (GIS) is a collection of tools that captures, stores, analyzes, manages, and represent the data that connected to certain geographical location. In other simple world, GIS is the integration of mapping and statistical analysis, hardware, software and data [2]. For the last few decades , there have been many efforts to develop GIS applications for the provision of traditional services and wide range of users all over the world. “Cloud Computing”, has taken the world of geographical information systems by storm . Often seen as a utopia of computing utility. Cloud computing provides financial benefits and flexibility is second to none. It also reduces the entry point to the high computing performance, allowing organizations to leverage the computing power they do not have the capital budget and operational experience to gain. Cloud computing is “the next natural step in the evolution of on-demand information technology services and products”[2]. Cloud Computing can be applied to solve and overcome the challenges in GIS applications .

List of figures:

Table of Contents

I. INTRODUCTION

Geographic information systems (GIS) is a collection of tools that captures, stores, analyzes, manages, and displays the data that are linked to geographical locations. GIS plays a key role in a wide range of areas, and depends on a large scale at the present time. In the simplest terms, GIS is the integration of mapping and statistical analysis, hardware, software and data. Geographic Information Systems Commonly used as a support for decision-making at the best possible data relationships through spatial and non spatial, visualization and processing [2]. GIS is a useful and works well when made available to as many people as possible in every place and time at the expense of resources are very less in terms of technology and expense. Over a few decades, and efforts are under way to develop GIS applications for the provision of traditional services and wide range of users all over the world [2]. "Cloud Computing", has taken the world of geographical information systems by storm. Often seen as a utopia of computing utility. Cloud computing provides financial benefits and flexibility is second to none. Cloud computing is a technology which can leverage every industry that provides or consumes software, hardware, and infrastructure. The technology and architecture that cloud computing provide , is current and future solutions of GIS products[6,7]. There are several variations on the definition of cloud computing, "Cloud computing furnishes technological capabilities that are delivered on demand as a service via the Internet". But The definition of the cloud computing is recently Disputed . As we will see in the literature Review how it is defined. The customers of this services do not own the assets of the cloud computing, In other word, they are renting the software, hardware, or Infrastructure from shared architecture. Main differences between clouding computing and Traditional

computing services are scalability and Elasticity in clouding computing. Instead of a static system architecture, Cloud computing supports the ability to rapidly scale the capacity of the provided service up or down, and also supports multi-tenancy which provides the ability of the system to be shared by many organizations or individuals. Virtualization technology also used in clouding computing . this allows the vendors of the cloud to divide one machine to virtual machines [6,7] . This paper provides background to where the cloud computing came from, what is cloud computing, and discusses some of the advantages and challenges with cloud computing, as well as how does the GIS enlist the clouding and explain a multi-level structure for the GIS Cloud proposed by Muzafar Ahmad Bhat et al.[2] .

Objective:

The aim of this paper is to Describe the cloud computing and demystify it. What is the cloud computing , gives background to where the cloud computing came from, and discusses some of the advantages and challenges with cloud computing, as well as how does the GIS enlist the clouding and a explain a multi-level structure for the GIS Cloud. For users of GIS technology , the cloud open new possibilities ,but what are these possibilities , and why might be better than what you are doing now ? In fact, why should you care about cloud computing at all ?

The goal for this paper is to answer these questions. After a quick introduction to cloud computing. At the end I will look at some concrete examples by exploring what Esri is doing today to bring GIS to the cloud .

Methodology:

In this paper I am going to present a clarify description of the concept of the cloud computing to the readers by putting a definition that all will accept of

any model of computing to identify as a cloud computing. The cloud computing is not a new technology but it is a result of collaboration of several existing technologies and call a model of computing a cloud computing if it is contain the four aspects: Elasticity, Multi-tenancy, Economics, Abstraction and will be explained in details in section II. . Also in general I will describe the architecture of the cloud computing by describing the cloud computing service layers and cloud deployment models as I will mention some of the benefits and challenges of the cloud computing. In section III. I will explain the GIS cloud, why we need GIS cloud, and GIS cloud architecture. In section IV the conclusion section V. will contain the references.

II. LITERATURE REVIEW

Cloud Computing

Cloud computing is not considered as a whole new technology but it is a result of collaboration of several existing technologies. The definition of the cloud computing is recently Disputed . the one that all will accept of any model of computing to identify as a cloud computing is contain the following aspects.

- **Elasticity**

Cloud computing is Characterized by its ability to dynamically scale up and quickly scale down, offering cloud consumers high reliability, quick response times, and the flexibility to handle traffic fluctuations and demand with little to no interaction from the consumer .This property, known as the elasticity (flexibility), is the key to cloud computing. and in some models of delivery

of cloud computing, making it easier and often flexibility through virtualization, although cloud computing does not require virtualization.

- **Multi-tenancy**

Clouds are inherently multitenanted, and even special clouds, which extends the workload of one company have multiple tenants , whether their workload or individual users. This multi-tenancy and multi-tenant consumption of computing resources is a common part of the reason behind the economic benefits of cloud computing.

- **Economics**

With cloud computing services, it is expected to be charging the consumer for the amount of time using the resources. Cloud computing changes the barrier to entry for high performance computing resources, by allowing consumers to use only what they need at a time when they need it. On the other hand, has allowed these organizations to respond effectively to the requirements of peak demand without the need for surplus resource sits idle during periods of deep sleep. This can be achieved through distribution of the load across multiple shared resources and relying on economies of scale.

- **Abstraction**

Determining cloud computing and the most important change with cloud computing is that of abstraction. most cloud providers provide one or more service layers to consumers. Isolation in the operational aspect of the layers supporting service of the customer . Therefore, software as a service (SaaS)as an example, the interactions of the user is with the application itself, but not with the operating system or hardware of the cloud . This fundamental difference allows organizations that do not have the necessary management system skills or the compute facilities of the enterprise applications hosted by others. Several technologies, which help to provide these capabilities present for many years. Virtualization and autonomic response are the areas of computing that have been well understood for several decades, also the Internet. The cloud computing providers are able to compile these different techniques in the capacities of the above, in the end determine the cloud computing.

Cloud Computing Service Layers:

- **Software as a Service (SaaS)** comprises end-user applications delivered as a service, rather than as traditional, on-premises software. The most commonly referenced example of SaaS is Salesforce.com, which provides a customer relationship management (CRM) system accessible via the Internet.
- **Platform as a Service (PaaS)** provides an application platform or middleware as a service on which developers can build and deploy custom applications. Common solutions provided in this tier range from APIs and

tools to database and business process management systems, to security integration, allowing developers to build applications and run them on the infrastructure that the cloud vendor owns and maintains. Microsoft's Windows Azure platform services are often referenced as PaaS solutions at this middleware tier.

- **Infrastructure as a Service (IaaS)** primarily encompasses the hardware and technology for computing power, storage, operating systems, or other infrastructure, delivered as off premises, on-demand services rather than as dedicated, on-site resources such as the Amazon Elastic Compute Cloud (Amazon EC2) or Amazon Simple Storage Service (Amazon S3)

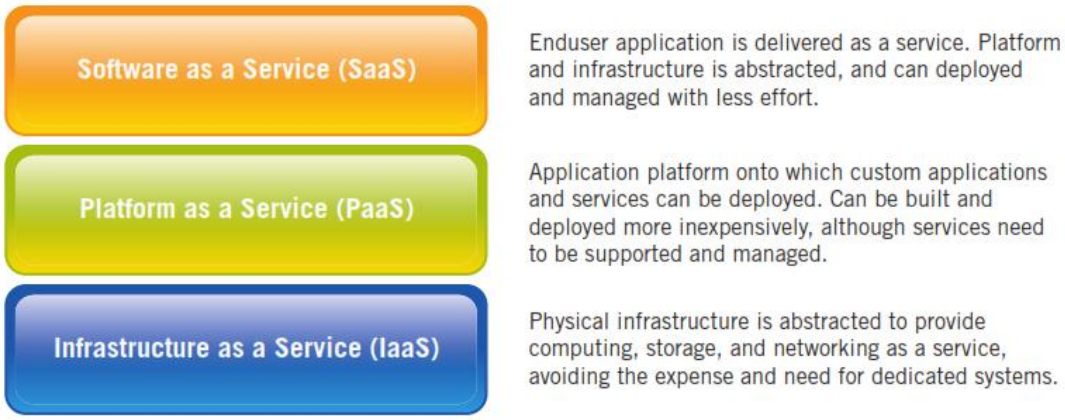


Figure 1 illustrate the Cloud computing service Layers .

Cloud Deployment Models:

There are several types of scenarios deployment of cloud computing. National Institute Of Standards and Technology (NIST) is emerging as the preferred supplier have Indeed, the definition of cloud computing
and distribution models, seen here in figure (2) , Victoria Kou. [5] , with some of the ESRI Examples.

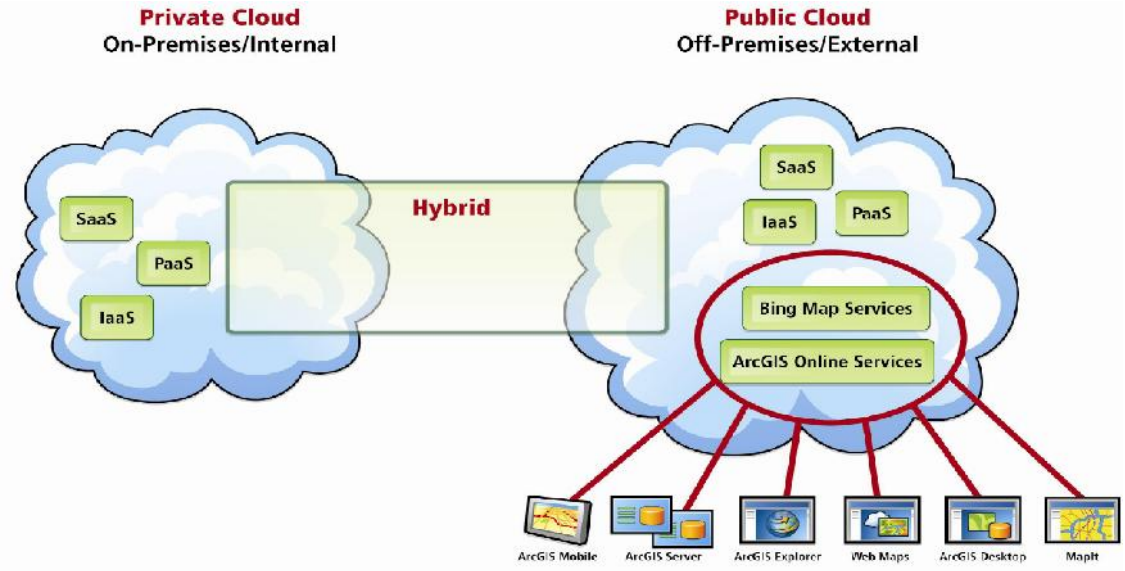


Figure 2 illustrates the Cloud deployment models

Public cloud is the most commonly referred to as the subject of cloud Computing, which is owned infrastructure and applications by the organization Selling cloud services. However, since many of the traditional vendors and users are not quite Ready to jump into cloud computing public or restricted from doing so. Copies of service levels within the private cloud environment, behind a firewall, and maintained within the parameters of the host organization. Many believe that the sweet spot to improve the cost Organization will depend on the delicate balance of public ,the community, the private clouds. However, since this hybrid cloud solution is commonly bound together by proprietary technology, it will only be embraced by enterprise computing in the future as standards are developed [5].

Benefits of Cloud Computing:

- Lower Total cost of ownership

  Reduce ongoing and life cycle costs.
- Increased availability

  Always on , always available.
- Faster application delivery

  Expedites time to market ; competitive advantage.
- Flexible model

  Scales by demand ; no wasted capacity .
- Enables collaboration and community computing

  Platform for easier and faster information sharing, mobile workforce.
- Improved business continuity

  Inexpensive disaster recovery options.
- Rental pricing model

  Pay-as-you-go ; pay-in-advance; try before you buy.

Challenges In Clouding:

Cloud computing is not without its challenges. Sensitive workloads that have strict quality of service requirements may not be appropriate for deployment to the cloud. Of particular concern are workloads with strict security and compliance requirements. Security and privacy are two of IT professionals' top concerns when considering moving to the cloud, either as a vendor, broker, or consumer. Typical security and privacy examples include data storage and data transfer protection; vulnerability management and remediation; personnel and physical security; application security; data privacy; and identity management.

III. GIS And CLOUD COMPUTING

GIS CLOUD

GIS is an Integrated System of Computer Hardware, Software and Spatial Data (topographic, demographic, tabular, graphic image, digitally summarized), performs manipulative and analytical operations on this data to produce reports, graphics and statistics and controls geographic data processing workflows.

According to the Buyya et al. [3], Cloud Computing is: "a type of parallel and distributed system consisting of a collection of interconnected and virtualized computers that are dynamically provisioned and presented as one or more unified computing resources based on service-level agreements". This definition reflects the fact that both compute and data exhaustive applications, such as GIS applications, can with good grace be moved to Clouds.

GIS Cloud has been a suggestive approach to upgrade the conventional GIS applications in order to provide broad spectrum services to the users across the globe. The extensive use of GIS over the decades has been put to a question mark whether to shift it to more superior alternative i.e. Cloud Computing Paradigm. Geographic Information Systems (GIS) applications have been moving into the cloud with increased drive, Global organizations like ESRI, GIS Cloud Ltd etc have already taken the quantum leap and taken a technological shift to Cloud Computing Paradigm and are committed to provide on-demand services to their extensive shades of

users. World's largest GIS Cloud infrastructure providers are Amazon (Amazon EC2 & S3), Microsoft (Microsoft Windows Azure, Windows Server Hyper-V), and IBM (IBM Cloud) which provide reliable and secure cloud IT infrastructure to the customers on-demand.

WHY GIS CLOUD ?

GIS Cloud provides authoritative tools which can help many businesses, especially, when optimization and cost reduction are critical. Some basic principles which characterize GIS Cloud to be accepted as the serious contender for next generation GIS computing paradigm are:

a. Providing Application Infrastructure
b. Support Technology Infrastructure
c. Plummeting Support and Maintenance
d. Reducing Implementation Cost
e. Leveraging Data Command
f. Location Independent Resource- Pooling
g. Data Conversion and Presentation

GIS CLOUD ARCHITECTURE

what Cloud Computing represents. For GIS applications the GIS Cloud can prove to be an approach to provide compute or storage capacity as a service, provisioned from a parallel, on-demand processing platform that leverages economies of scale to varied shade of users and organizations requiring GIS application services. Having said much about the GIS Cloud capabilities, it becomes very imperative to understand the underlying architecture of GIS Cloud system. Figure (3) [2] shows GIS Cloud architecture which can be followed to develop a consolidated, elastic pool of compute and storage system to gather, manipulate, analyze, and display spatial data.

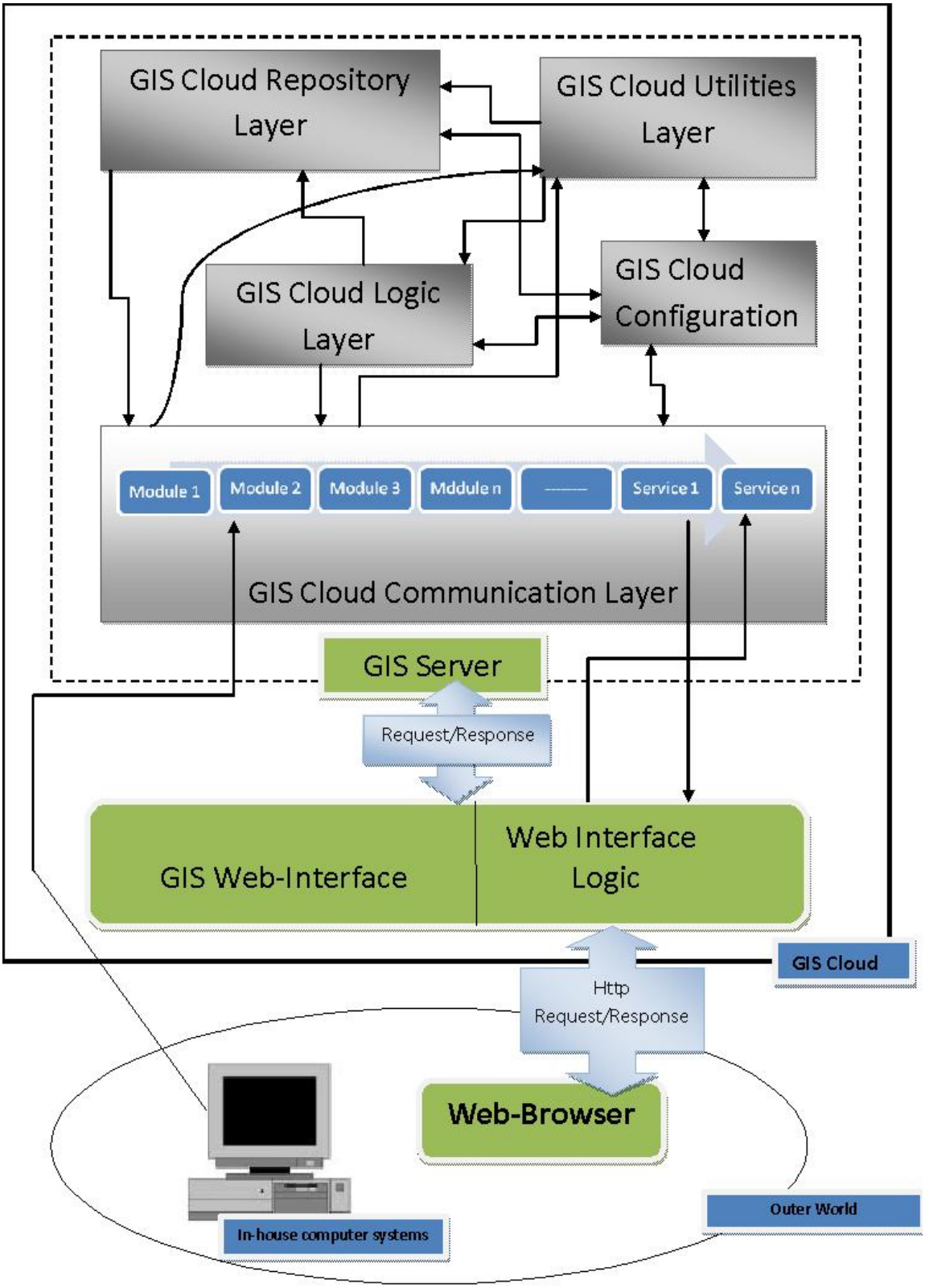


Figure 3 illustrate GIS cloud architecture

The GIS Cloud architecture can be broadly divided into two major components which are:

- GIS Cloud Web-Interface.
- GIS Server.

A. GIS Cloud Web-Interface

The idea behind GIS Cloud Web-Interface is to provide flexible, robust and cost-effective web-based interface to the users by taking advantages of Web 2.0 and associated technologies. The GIS Cloud Web Interface will be one of the core components of GIS Cloud which will be actually a zero downtime web application with real-time content updates. The main aim will be to provide users a better experience by downloading it in less than 10 sec. Allows user personalization and complete interactivity. Make content available using varied technologies like broadband, mobile, RSS etc. and enhance employee productivity by creating a CMS which executes the workflow (from accessing raw content and delivering the processed copy) for publishing content in 3-5 minutes in routine situations and have exceptions to the process to take care of Emergency scenarios. Allow the GIS team to analyze user behavior and all online properties like online map production to chart out a more robust future growth roadmap and allow users to view, edit and integrate maps in the system. Integration of all elements, which allows interlinking of geospatial information in terms of text /audio/video/maps etc with each other across the spectrum.

B. GIS Server

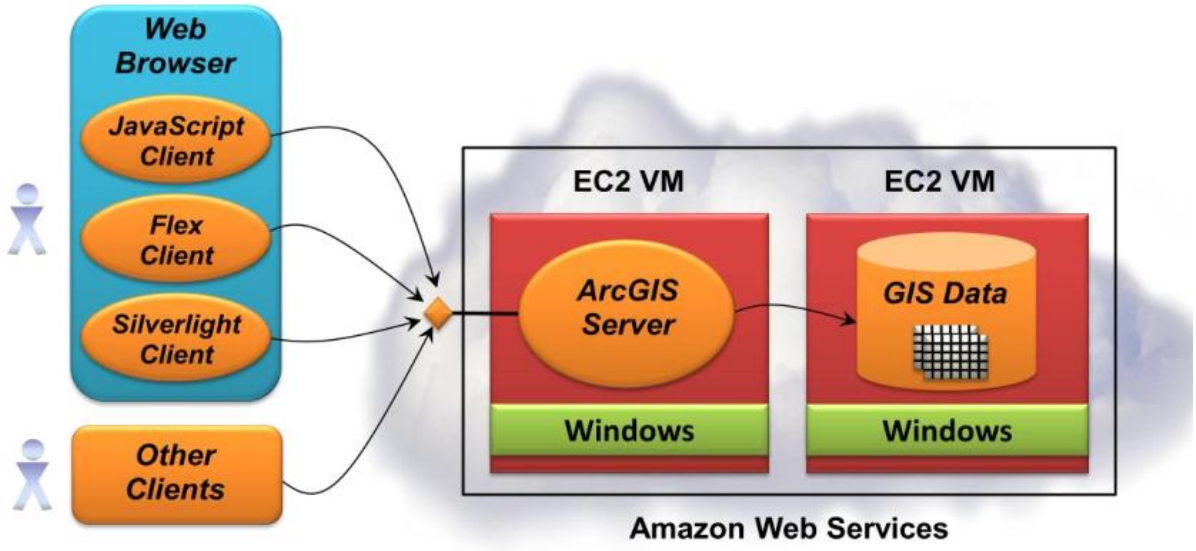
The idea behind GIS Server is to have scalable computing resources for GIS Cloud that manages shared resources such as databases, configuration, server logic, server side utilities, communication interfaces and high powered processing infrastructure. The GIS Cloud Server will be composed of five tiers or layers which are:

- GIS Cloud Communication Layer
- GIS Cloud Repository Layer
- GIS Cloud Utilities Layer
- GIS Cloud Logic Layer
- GIS Cloud Configuration Layer

Since one of the core characteristics of Cloud Computing is ubiquitous network access i.e. accessing cloud services through standard internet-enabled devices eliminating the bottlenecks for information access. The GIS Cloud System will be accessed either by GIS Cloud Web Interface or by the In-House computer systems located at the GIS-Service provider organizations[2].

VII. EXAMPLES OF GIS IN THE CLOUD

- **ArcGIS Server on The cloud**: Today customer typically deploy arcGIS server on their own data center.But it also deploy it on the cloud .Figure 4 shows , that ArcGIS it self can be run on Virtual Machine(VM) on the Amazon Web Server and another VM to the GIS data.



Figur 4 ArcGIS Server can be deployed in an EC2 VM on Amazon Web Services.

- **ArcGIS.com**: using the internet to share the system and the data. Figure 5 shows, the web page of ArcGIS.com. The link of the website is http://www.arcgis.com/home/ .

Figure 5 : Home page of ArcGIS.com

IV. CONCLUSION

This paper discusses and explains the Cloud Computing architecture by describing the cloud computing service layers and cloud deployment models as well as some of the benefits and challenges of the cloud computing and how it approaches to GIS applications and the benefits of implementing former for later applications. Also it explains the GIS cloud, why we need GIS cloud, and cloud architecture for GIS Cloud System which is a consolidated, elastic pool of compute and storage system to gather, manipulate, analyze, and display spatial data. Although this is a conceptual framework but is a strong contender for meeting the high level demands of GIS applications and a well engineered Cloud Architectures for such applications can potentially improve the scalability, accessibility and usability of GIS resources.

V. REFERENCES

[1]Muzafar Ahmad Bhat, Razeef Mohd Shah, Bashir Ahmad and Inayat Rasool Bhat, December 2010, "Cloud Computing: A Solution to Information Support Systems (ISS)," International Journal of Computer Applications 11(5), 5–9. 2010.

[2]Muzafar Ahmad Bhat et al., 2011 , "Cloud Computing: A solution to Geographical Information Systems (GIS)," International Journal on Computer Science and Engineering (IJCSE).2011.

[3] Rajkumar Buyya, Chee Shin Yeo, and Srikumar Venugopal, "Market-Oriented Cloud Computing: Vision, Hype, and Reality for Delivering IT Services as Computing Utilities," Keynote Paper, Proceedings of the 10th IEEE International Conference on High Performance Computing and Communications (HPCC 2008, IEEE CS Press, Los Alamitos, CA, USA), Sept. 25-27, 2008, Dalian, China.

[4] Spatial Cloud Computing (SC2) White Paper 2009: "A New Paradigm for Geographic Information Services," Presented by: Hugh Williams, SKE Inc. August 2009.

[5] Victoria Kouyoumjian , ESRI White Paper 2010: " The New Age of Cloud Computing and GIS," .

[6] Omkhar Arasaratnam ,"Introduction to Cloud Computing"

[7] Dialogic Corporation, White Paper," Introduction to Cloud Computing ".

[8] David Chappel ,ESRI White Paper 2010 ,"GIS in the cloud".

[9]http://news.zdnet.co.uk/security/0,1000000189,39290616,00.htm

[10]http://www.techcrunch.com/2009/03/07/huge-google-privacy-blunder-shares-your-docswithout-permission/