Integration of GIS and Cloud Computing for Emergency System

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***Abstract*—latest evolutions in GIS technology and spatial information acquisition technology have led to a more distributed data method and computing environment. "Cloud" expertise has appeared as technologies by its focus on large-scale asset sharing and reduced cost for large-scale data storage technology. Specially, the problems of big volume of spatial data in some of the emergency cases which make the needs for elastic way for storing and analysis and computing all of these resources. In this paper we proposed an aechitecture for spatial data processing based on cloud computing technology. The results showed better performance in comparison to previous works.**

***Keywords*— cloud computing, cloud GIS, Amazon EC2, Google maps API.**

I. INTRODUCTION

GIS has a long history of successfully adapting to new technologies, applications, customer types, and business models. From mainframes to minicomputers, UNIX workstations to PCs, desktops to the enterprise, each round of technical innovation has led to improvements for GIS Today.

One of the greatest usages of GIS is in emergency management systems such as Natural Disasters that Impact Humans (Earthquakes, Volcanoes, Tsunamis, Landslides, Fires, Floods, Tornadoes, and Hurricanes).

Advances in remote sensors, photogrammetric instrument, laser scanner, and radar have created huge collections of spatial data, capturing spatial information of value to emergence management. We face unprecedented challenges in the field of big spatial data management and analysis in emergence system today**.**

Cloud Computing is defined as 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[1].

It is very necessary to establish a highly efficient, fast and responsive monitoring and analysis and early warning network to provide effective spatial information services, which can meet the needs of a variety of monitoring functions of the emergency management.

Such a disaster monitoring network provides a platform, in particular, a spatial information platform, which allows users to obtain a variety of data through the network in real-time access, analysis and process. Also, monitoring network allows users to receive timely the feedback information to understand the monitoring object; including its three-dimensional changes in the state, if necessary, employed by the spatial support, to give the right response, and to take corresponding measures [2].

There are several problems facing GIS, which challenge the management and analysis of special data that collected to serve different applications such as emergence management system, Such as:

- Restricted in size and availability.
- The need to be reserved for usage.
- Limited storage space both locally and in network.
- Setting up of clusters need large amount of initial investment.
- Failure rates are very high given their use by large number of people (sharing mode).
- Maintenance can be very expensive and
- Time consuming for real-time GIS applications.
- Applications Too much overheads.

These problems make the role of GIS in emergence system not efficient because of the huge data that have been collected by remote sensors, photogrammetric instrument, laser, scanner, and radar. Capturing spatial information of value to emergence management [3].

In This research, we try to find an architecture that will integrate GIS with the cloud computing technology. This integration will solve the traditional GIS problems, so it will be helpful in large-scale spatial data, especially in emergency management system.

To solve the big spatial data technology in emergence management. Also, to provide effective spatial information services is the aim of such a spatial information platform to better for spatial data analysis and support in emergence management.

This paper is structured as follows: section II introduces the related works of cloud GIS and cloud GIS, section III describe the proposed architecture, section IV discusses the results of proposed architecture. Finally section V contains the conclusion and future works.

II. OVERVIEW OF RELATED WORKS

A. cloud computing

Cloud computing has become a significant technology trend, and many experts expect that cloud computing will reshape information technology (IT) processes and the IT marketplace [6].

Cloud computing can much improve the availability of IT resources and owns many advantages over other computing techniques. For example, it can provide self-help services without need any manual interactions with service providers. And all the resources on the cloud are transplant to the users, that is, users can dynamically lease physical or virtual resources and don't need to know the exact places of the resources existed. Besides, all the resources on cloud computing platform can be quickly and elastically deployed [1].

According to **NIST**, National Institute of Standards and Technology, Cloud Computing is:

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 or service provider interaction [4].

B. web GIS for emergency management

There are many researches on the application of GIS-based cloud computing to solve the special problems of emergency management systems.

Emergency management faces difficulty in managing emergency data because it involves the integration of multiple heterogeneous sources, multiple agencies own the relevant data and possess parts of emergency related knowledge.

The emergency WebGIS platform is mainly for every sector of the government emergency management, for major unexpected events to the analysis of high-performance, contingency management and disposal of spatial information systems to support decision making [7].

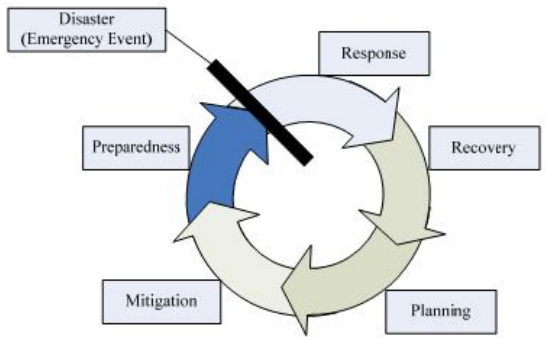

Fig. 1. describes the phase of emergency management .

C. cloud GIS researches background

GIS and IT professionals quickly put together a GIS-based web mapping application in response to an overwhelming demand for information about each event. Traffic to these websites has demonstrated that the public is just as interested in timely, accurate, interactive maps as emergency responders and government officials

There are number of researches to use cloud computing technology in GIS applications. These researches can be classified into two categories from purpose viewpoint:

Category 1: cloud GIS application for specific or private use

These applications such as web GIS for emergency management (volcanoes, fire, earthquake...etc.) , marine, E-government GIS application, SARS prevention and so on.

Category 2: cloud GIS application for general or public use.

Such as GIS application based on general model for user who will pay only for rent the service he will get.

Example" www.GISCLOUD..com"

The following architecture is a design of general GIS platform architecture on the cloud computing which is showed in Figure (2). The GIS users are expected to access these services easily and transparently with low costs, because they only need to rent all computation resources when needed without their own infrastructure [5] .

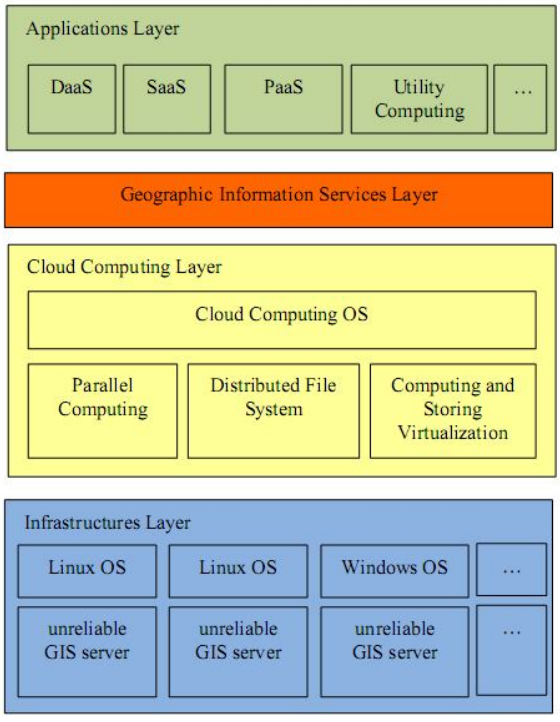

Fig. 2. General GIS cloud based Architecture.

D. cloud GIS platforms

There are number of cloud providers which support dealing with both cloud technology and hosting or deploying GIS application. The most provider are Amazon EC2, Google App Engine, Microsoft Windows Azure. Based on comparison on[8] , Amazon EC2 support the following criteria:

Challenge	*Amazon EC2*	*Windows Azure*
Availability	*Zones, Regions, Elastic IP Adress with Guaranteed Network availlability 99.95%*	*Fault – tolerance, Geo Replication, REST and manged API For storage. With guaranteed network availability 99.9%*
Resourse Scaling	*Free auto scaling enabled by cloud watch*	*Paid, based on a configuration file specified by the user*
Data Deletion	*Delete objects in Amazon S3and delete item and attributes in Amazon SimpleDB*	*Remove all references with garbage collection*
Data Lock-in	*Use Gluster to move between public, private , hybrid clouds*	*No feature to support moving between clouds*
Data Security	*Security applied within multiple levels . Encryption can be done by user.*	*Seurity mechanisms applied at diferent layers. Security in SQL Azure is similar to that in SQL Server.*

Amazon Elastic Compute Cloud (Amazon EC2) is a web service that provides resizable compute capacity in the cloud. It is designed to make web-scale computing easier for developers. Amazon EC2's simple web service interface allows customers to obtain and configure capacity with minimal effort. It provides customers with total control of computing resources and lets them run on Amazon's resilient computing environment. Amazon EC2 reduces the time required to obtain and boot new server instances to minutes, allowing customers to quickly scale capacity, both up and down, as computing requirements change. Amazon EC2 changes the economics of computing by allowing customers to pay only for the resources that customers actually use. Amazon EC2 provides developers the tools to build failure resilient applications and isolate themselves from common failure scenarios [8].

III. PROPOSED CLOUD GIS ARCHITECTUR

We have integrated GIS with the cloud computing technologies. GIS Cloud is the use of GIS in Cloud Computing System which enables uploading, editing and analyzing geospatial data. The objective is to provide the power of desktop GIS solutions on web based platform. we have built the system using Amazon EC2 as cloud infrastructure.

B. architecture components and layers

The following architecture describes the layers of the proposed cloud GIS application for emergency management.

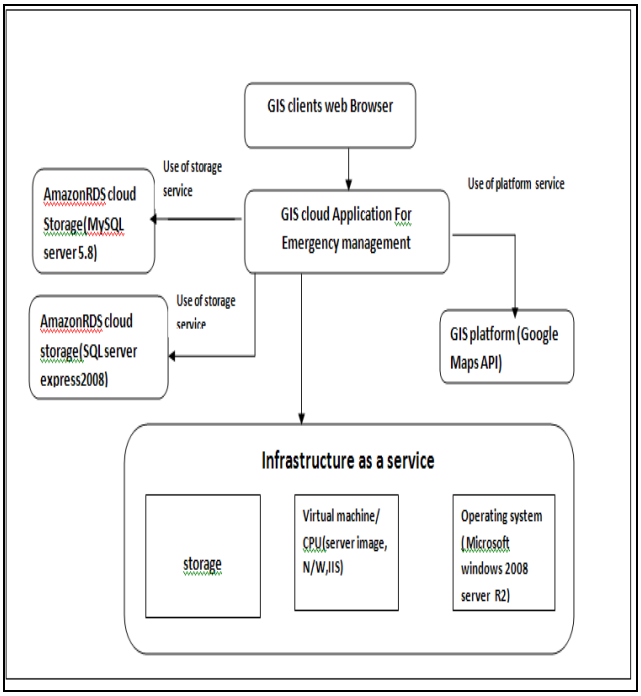

Fig. 3. Proposed model for integrating GIS application with Amazon EC2 technology for emergency management

1- Client Layer (CL): CL is the GUI directly oriented to users. Like client layer in distributed-GIS, CL in cloud system plays similar roles such as enabling user to manipulate spatial data and information.
2- The Application Service Layer (ASL): ASL contains emergency management application which clients can

organize their data in order to form an IS and produce decision making.

3- GIS platform layer: In this layer Google maps API utilities to support the optimization and seamless functioning of the GIS Cloud System as a whole focused GIS utilities for address lookup, mapping, routing, reverse geocoding, and navigation.

4- GIS Cloud storage layer: in this layer we used the utilization of Amazon RDS (relational Database Service) to deal with different database providers such as MySQL server and SQLServer2008 on AmazonRDS

5- Infrastructure layer: in this model Amazon EC2 is proposed to be used as cloud infrastructure provides complete control of computing resources running on Amazon's proven computing environment by using virtual machines physical storage, operating system.

C. System Features and modules

- The emergency management system is responsible for management of different resources from different organizations in case of emergency by connecting the emergency management database to the organization's databases that carry the resources' information.
- Our system has the ability to connect to different database providers for different organizations on the cloud to retrieve different resources information.
  We have use ambulance database on MySQL server and fire database on SQLServer2008 on AmazonRDS as a test case.
- Google Maps API is used for map visualization
- Geocoding: convert the address to location (Longitude, Latitude)
- Reverse Geocoding: convert the Location to address
- Shortest path calculation: Calculates the shortest path between the resource location (Emergency Team) and the incident location and generate instructions list.
- Get the nearest team to the incident location

D. implementation of proposed model

The implementation of the previous proposed model can be described as the implementation of web GIS interface cloud based for emergency management which locates data from different organization about its recourses. Then we use the power of platform as a service by determining the suitable resources for a specific incident and using the calculation of shortest path

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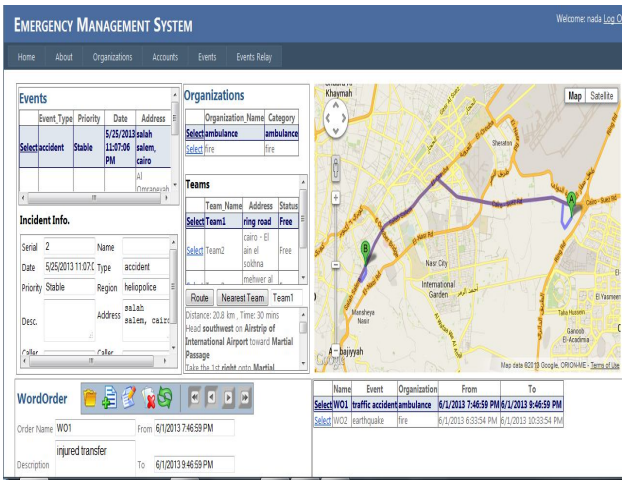

Fig. 4 implementation of GIS application with Amazon EC2 technology

IV . RESULTS

The following results have been obtained of our system which used the Amazon cloudwatch service. Amazon CloudWatch monitors AWS resources such as Amazon EC2 and Amazon RDS DB instances, and can also monitor custom metrics generated by a customer's applications and services. With Amazon CloudWatch, you gain system-wide visibility into resource utilization, application performance, and operational health [9].

Amazon CloudWatch provides a reliable, scalable, and flexible monitoring solution that you can start using within minutes.

The following figures describe Amazon EC2 Instance CPU utilization of in percentage according to a specific period of time and Network IN and Network OUT.

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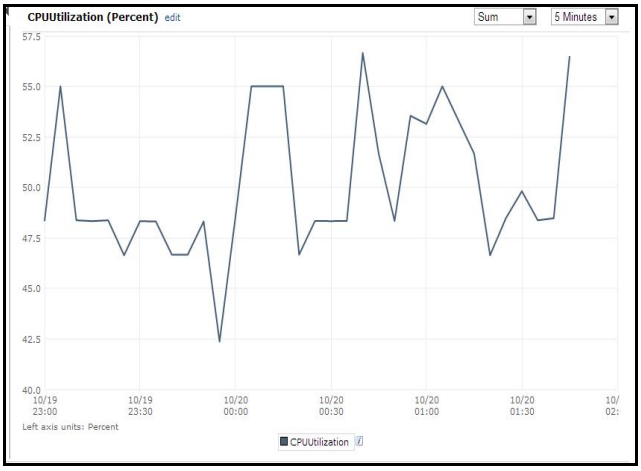

Fig. 5. Amazon EC2 CPU utilization metrics

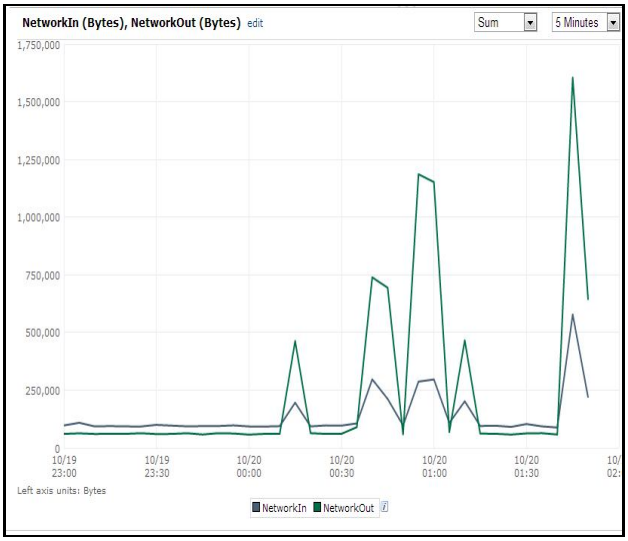

Fig. 6. Amazon EC2 network in and network out (measured by bytes) metrics

IX. CONCLUSION

Using cloud computing technology provides a plethora of benefits for GIS applications as compared to the traditional approaches. This paper discussed cloud computing technology in the GIS application, first introduced the concepts of cloud computing; Then the paper focused on how to apply the cloud computing techniques in the GIS spatial data storage and processing, as well as its impact on GIS software development and product patterns; we proposed a model in which the process of integrating GIS application into cloud platform. Finally We implemented this model using Amazon EC2 as cloud computing platform, power of processing and storage of GIS applications have been done to enhance particularly the emergency management system .

There are still problems that needed to be improved in this article such as applying, enhancing the proposed model to support raster data of GIS system. also using full utilization of computing services in the cloud computing infrastructure to host large volume of data as possible using Amazon storage services such as Amazon S3. ArcGIS Server one of the Successful experiences can be used with Amazon Web Services but it was very costly to be used.

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