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A framework for integrating geospatial information systems and hybrid cloud computing☆

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ABSTRACT

Many decisions are made daily based on the simple mental processing. This way of decision making is suitable for the simple personal daily issues. But when decisions are concerned with general and sensitive sectors, this way of decision making is unacceptable. Nowadays, Geospatial Information Systems help in making more accurate decisions in a lot of sections that would be built on accurate information by way of drawing maps and visualizing data to clearly judge which option is the best for that particular situation. This paper raises a framework that integrates the Geospatial Information Systems with the Hybrid Cloud Computing to let them work together and get greater powerful benefits via applying the concept of cloud computing to overcome the flaws related to the desktop GIS including the huge startup cost and the storage capacity and to provide the feature of location independence accessibility where the GIS can be accessed from anywhere and anytime. The hybrid cloud computing was picked to be integrated with the GIS to gain the elasticity and security of dealing with different types of data; private and public data. This integration is presented in three dimensions. The first one is architecture with seven segments that illustrate the main structure for the Hybrid Cloud GIS within a mix of private environment and public environment. The second one is the types of the participants and their workflow within the two environments. The last dimension is a case study for applying this integration in the health sector in Egypt.

1. Introduction

Recently, Cloud Computing (CC) was raised to help in solving a lot of problems in a wide range of different sectors. By using (CC), it became much easier to handle a large amount of data and services with a less cost using the utility of pay-as-you-go (PAYG) which is a computing billing method implemented in cloud computing. It allows the user to scale, customize and provision computing resources, including software, storage and development platforms where the resource charges are based on the used services. Cloud computing also gives access to these data and services without time or location dependency.

As it's one of the cloud deployment models, hybrid cloud is a cloud computing environment which uses a mix of private cloud and public cloud services with orchestration between the two platforms. By letting workloads to shift between public and private clouds as computing costs and needs change, hybrid cloud gives greater flexibility and more data deployment options. While (GIS) is playing an important role in a lot of sectors, its value would be much bigger by getting the access to its services 24/7 regardless the location and the time where an internet connection is all you need.

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This paper presents a Hybrid Cloud GIS framework with three dimensions. The first dimension is a seven segments' architecture for integrating the hybrid cloud computing with the GIS. Those seven segments are designed to cover the whole integration between the GIS and the two environments of the Hybrid cloud. The second dimension is the participants' workflow where the users in this framework are categorized to insiders and outsiders dealing with two different environments; public and private. The third dimension is an applied case study on one of the most important sectors which are the health sector to clarify the importance of the Hybrid Cloud GIS framework in solving the most common problems related to this sector and improving its services.

The Paper is divided into six sections. The first section gives the introduction. While section two gives a brief explanation of the concepts used in this research including the Cloud Computing definition, characteristics, deployment models and services and the GIS. The third section explains the related work that has been done by other researchers in the field of Cloud GIS. The fourth section demonstrates the suitable CC deployment model used in this research by explaining its advantages, disadvantages, and requirements. The fifth section elucidates the framework with its different dimensions. The last section gives a summarized conclusion for the gained results.

2. Background

This section gives a brief explanation of the concepts used in this paper including the Cloud Computing and the GIS where Cloud explains the use of a compilation of applications, services, information, and infrastructure composed of pools of computers, information, and network and storage resources. Cloud computing alludes to the use of networked infrastructure software and capacity to offer resources to users on-demand environment. With cloud computing, information is cached temporarily on clients that can include PCs, notebooks, and other devices and stored in centralized servers [1]. According to (NIST) National Institute of Standards and Technology, Cloud Computing was presented as a model for offering suitable on-demand network access to a shared pool of computing resources including servers, storage, applications, network, and services that can be quickly released and provisioned with minimal service provider interaction or management effort [2].

The cloud computing characteristics are five main characteristics. The first characteristic is that cloud computing is considered as on-demand service which means getting computing capabilities as needed automatically. The second one is the broad network access where the services are available over the network using PCs, Laptops…etc. The third one is the resource pooling where the provider resources pooled to serve multiple clients. The fourth one is the rapid elasticity which gives the ability to quickly scale in and out of services. The fifth one is the measured service where controlling and optimizing the services is based on metering [3].

The cloud computing deployment models are four different models. The first model is the public deployment model where it's owned and operated by one organization and its services offered to the general public. The second model is the private model where it's owned and operated by one organization but its services offered to their internal users only. The third model is the community model where it's owned and operated by organizations of a specific community. The fourth model is the hybrid one which is a composition of two or more clouds (Public, Private, and Community) [4].

Hybrid Cloud consists of at least one public cloud and at least one private cloud. It's regularly offered in one of two ways: a dealer has a private cloud and makes a partnership with a public cloud provider, or a public cloud supplier makes a partnership with a dealer that offers private cloud platforms. Its infrastructure is well presented as an integration of two or more different clouds that leap together by proprietary technology that enables application and data portability. In a hybrid cloud, an organization manages and provides some of the resources out-house and some in-house. It gives the scale and cost benefits of public clouds, while also it gives the control and security of private clouds. The hybrid cloud has an extra data privacy and security than the public cloud where the data is spread between at least two zones. Also, it has lesser establish cost than the private cloud. According to the distribution of data through different zones, important data would be stored in the private district to be only accessed by the allowed users while other data would be stored in the public district to be accessed by public users [5].

The services of the Cloud Computing are mainly categorized into three categories. The first one is the software as a service (SaaS) where the applications are running in the cloud. It presents an architecture that can run several instances of itself regardless of location. The second one is the platform as a service (Paas) where it's a platform that enables the developers to write applications to run on the cloud. It would usually have several application services available for quick deployment. The third one is the infrastructure as a service where it's a highly scaled redundant that shares the computing infrastructure to let it be accessible by internet technologies. It consists of servers, storage, security, databases, and other peripherals [6].

As a computer-based tool, Geospatial Information System (GIS) is used for storing, collecting, retrieving, transforming and displaying spatial data. GIS offers facilities for data management, data manipulation, data capture, analysis, and presentation [7]. GIS is the combination of cartography, statistical analysis, software, hardware, and data. GIS is usually used as a supporting system for decision making by offering best possible decisions through non-spatial and spatial data relations, processing, and visualization [2]. With GIS it is easy to draw maps and visualize spatial distributions. Also, it allows editing and altering existing data and accurately measure distances and areas. The uses of GIS in the health sector are extremely valuable including preparing and viewing diseases maps to easily track diseases and control it over time. It also helps in mapping populations at risks to make accurate saving plans. In addition to identifying accurately the healthcare areas and determine the shortage areas [8].

As a result of integrating the Geospatial Information systems with the concept of Cloud Computing, Cloud GIS was proposed as a valuable approach to give broad range services to the users across the world [3]. The widespread use of GIS over the decades has been put to a big question mark whether to move it to new better option i.e. Cloud Computing paradigm [4]. Geospatial Information Systems (GIS) applications have been moving into the cloud with an enlarged drive. International organizations like GIS Cloud Ltd, ESRI, etc. have taken the quantum jump and taken a technological move to Cloud Computing Paradigm and are dedicated to offering