Significances of Cloud Computing in Geospatial Technology

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ABSTRACT: *Geospatial, as the name implies is a combination of geographical and locational aspects that strives to explain an area of interest from a qualitative and quantitative perspective. Due to the advent of a myriad amount of cost-effective data capturing devices of late, there exists a space crunch for storing, analyzing and processing them to fetch meaningful and productive information. If one wishes to satiate the quench for effective data processing with minimal costs, Cloud computing environment is hard to resist as it provides ready to use preconfigured services at ease.This Paper attempts to tap the benefits of Cloud services and research on ways in which a seamless integration of the two domains can be done for the benefit of end users.*

Key Words: *Cloud computing, GIS, Cloud services, Cloud GIS*

Introduction

Cloud computing, is a virtual environment that provides a suite of tailor-made applications, system resources, and networking elements to it are Consumers on a "pay as per usage" basis. In common parlance, it is much like leasing a house for a particular tenure upon doing which one can make use of all the commodities that exist within it. Cloud computing concept is analogous to leasing where the suite rented by the consumer takes the place of the house and the resources that of commodities. Though numerous dominant players currently exist in the service providing market, Amazon Web Services (AWS) pioneered this front way back in 2006 which proved to be a revolutionary step in the Information Technology (IT) environmentby drastically reducing the expenditure involved in setting up an IT infrastructure. As setting up an IT environment is not economical by any means which involves resources in the likes of Servers, routers, modems, optical fiber cables,etc, a cloud service at an affordable rate is of invaluable importance. Now that perception about Cloud service is achieved,some ofits types are discussed.

- Public Cloud:These are the services administered by commercial providers such as Amazon Web Services, Microsoft and Googlewhich have their very own Data Centers that heed to a consumer's request via internet free of cost or via direct connect on a pay per usage basis.
- Private Cloud:Also known as Enterprise Cloud that is adopted internally within an organization for their specific needs and can be maintained either by the organization itself or by a third party. Maintaining a cloud service demands setting up a data center that can be laborious and expensive which made this type to be the least preferred.
- Hybrid Cloud: It inherits the characteristics of both Public and Private cloud types as it tries to transcend the boundary that is drawn between two cloud service providers which can be very useful in scaling which literally means altering the computational performance of a device/resource in accordance with the fluctuating demand.Say, for instance, an IT Organization that is running a Private cloud service type runs out of steam to cater specific needs of the Consumer who in turn can demand the services of a Public Cloud provided they are connected together. This phenomenon is called Cloud Bursting which indicates the bursting of a cloud on excess demand only to seek the services of another big cloud.

The computing procedure that is undergone in Cloud platforms are in a distributed way and hence getting the name Distributed Computing which means rather than a single working computer system, the components of a group of systems that are connected via network work in tandem to achieve a common goal where the inter-component communication is held via channels like Hyper Text Transfer Protocol (HTTP).The Channel serves as a medium for passing messages from one component to another in two ways namely,

- Synchronous message passing: Message sent by a component as a request via a channel gets complete only if it is fully received by the receiver, In other words, both the sender and receiver components must be active at the time of communication.Since Distributed systems can exist geographically apart which greatly question their activity at a communicating instance, the synchronous type does not hold good for them

- Asynchronous message passing: This mechanism differs by making use of a Middleware that acts a storage medium (Message Bus) which temporarily holds messages that were passed to be executed by the receiver if the latter is offline or inactive at the communicating instance.

Methodology

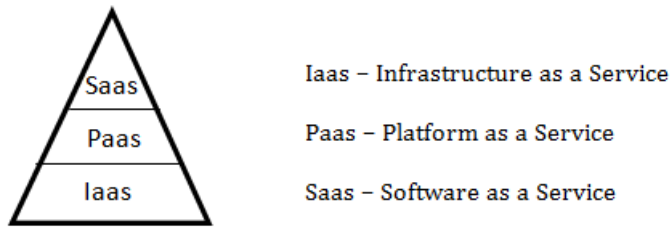
Since the very purpose of this paper is to find out ways for tapping the benefits of Cloud environment in Geospatial domain, certain questions have been formulated and tried to answer in the subsequent sections,

- Why Geospatial technology is in need of Cloud Platforms?
- Can Cloud live up to its expectations?
- What is in store for the future?

Each question is framed in such a way that the technology of interest's scope is discussed elaborately so as to cull out different ways of incorporation in the current Geospatial aspects.

Analysis

The need for Cloud:If a Cloud environment can be classified based on it's Consumers' strength and needs as Public, Private and Hybrid, it can further be classified based on its services as three different models namely,
Infrastructure as a Service
Platform as a Service and
Software as a Service
These models equip Consumers with different sets of resources that are needed for specific purposes.



This Service pyramid diagram depicts each Service as a Layer that acts as a foundation for another layer to be built upon it. Each service's idiosyncrasies and importance in Geospatial domain are detailed henceforth.

- **Infrastructure as a Service(Iaas)**

This model encapsulates the very aim of Cloud platforms by providing the users a virtual environment that comes with a flurry of virtual machines, servers and storage mediums for computing efficiency, a fitting example for this would be the Amazon Web Services which provides a Hypervisor to the concerned user on request for managing virtual machines. A Hypervisor, which can be a software or firmware is rolled out online by the cloud service provider for the user that creates a cluster of virtual machines from a single machine thereby literally increasing the computational and storage resources manifold.The machine on which the Hypervisor operates is the Host machine and the virtually created machines are the Guest machines, though Servers are virtually available it is up to the user to configure them according to his/her needs.

When it comes to Geospatial activity, due to the enormous amount of data being generated and transmitted by numerous interconnected devices ranging from weather to traffic sensors thanks to the Internet of Things (IoT) technology, a Cloud infrastructure is of paramount importance for performing spatial analytics and extracting otherwise obscure patterns from them. As an Infrastructure, it can pave way for a Geospatial cloud that involves storing, manipulating and processing large datasetsin a thrifty manner.

- **Platform as a Service(Paas)**

Apart from serving utmost requirements in the form of Infrastructure, Cloud model can also serve as a platform for developing, testing and deploying user-created applications by providing tools required to accomplish them such as Runtime components and Middlewares.As opposed to Infrastructure service that demands configuration of virtually created servers, a platform service allows for the least manipulation of given resources thereby significantly reducing a User's control over it which can prove to both boons as well as a bane. Say, for instance, ArcGIS for Server, a licensed server extension of the proprietary GIS software ArcGIScan be deployed as a platform for publishing, editing and consuming various GIS-related services via Cloud Infrastructures like Microsoft Azure. Though Platform services ease out the effort taken in

configuration and management, it falls short on offering good control over the resources it offers to the users.

- **Software as a Service(Saas)**

Knowingly or unknowingly many applications/software we use in daily life belong to this model, a common example would be the search giant Google's email application Gmail. Gmail is an application we access only via a network that has its own database which collects and organizes emails in a specific manner and more importantly the user who owns an account in Gmail application cannot accessit's Server. This restriction towards Server accessibility while providing virtual resources like storage and analytics is what makes this service stand apart from the rest. In a crux, licensing and utilizing the functions of software for a stipulated or extended period of time in an either free of cost or paid mode is what Software service is all about. ArcGIS online and Mango are some online mapping software that enable users to perform analytical tasks such as correlation among spatial features and eventually produce results in the form of maps. As the service takes care of storage and database requirements itself with a least concern about system specifications, even rudimentary systems can tap the benefits of it provided they are connected over a network. Say for instance, instead of installing a desktop based ArcGIS software in a machine, it's online counterpart can be accessed whenever required.

Though these Cloud delivery models are not inferior to one another, Iaas has a slight edge over the rest as it gives carte blanche to the end users in terms of managing a cluster of machines, picking and choosing their operating systems, runtime components and middleware while the other two especially Saas literally allowing one to use a predefined application.

Can Cloud Deliver?

In simpler terms, the goal of Cloud computing is to get rid of the costs involved in the procurement of hardware and networking elements by virtualizing and making them accessible at affordable rates. Even though it has not garnered much traction in developing countries like India for now especially in the geospatial field, it is highly expected to in the near future due to the abundance in data and alarming inflation rates that have led to more costlier infrastructure components. Further, an Organization's expenses can be greatly curbed by eliminating unnecessary workforce deployed for the setting up and management of infrastructure resources. By keeping these things in contention, incorporating Cloud-based models can do more good to an individual/organization's needs than harm.

Road Map ahead

Internet connectivity is inevitable for achieving a cloud environment as every desired resource is bound to be accessed online, further collaboration of IoT sensors with cloud platforms can aid in real time analytics being done such as identifying real-time traffic congestion hotspots using data generating from traffic sensors and appropriate spatial analytic tasks. Taking cognizance of the fact "Nothing online is foolproof", Cloud systems are no strange to that as proper security measures have to be taken in ensuring user's privacy by appropriate usage of private and hybrid models as and when required.

Conclusion

Cloud computing types, models and their importance in real-world scenarios were briefly discussed with a geospatial touch. Cloud computing is a coming thing but unfortunately,the IT sector in India is not fully prepared for it due to lack of awareness about its merits. Though demerits do exist in the form of security concerns and connectivity constraints, they are worth implementing in a country that is on a path where the service sector is said to be it's the future backbone.

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