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Fog Computing Architecture for Scalable Processing of Geospatial Big Data

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ABSTRACT

Geospatial data analysis using cloud computing platform is one of the promising areas for analysing, retrieving, and processing volumetric data. Fog computing paradigm assists cloud platform where fog devices try to increase the throughput and reduce latency at the edge of the client. In this research paper, the authors discuss two case studies on geospatial data analysis using Fog-assisted cloud computing namely, (1)Ganga River Basin Management System; and (2)Tourism Information Management of India. Both case studies evaluate proposed GeoFog architecture for efficient analysis and management of geospatial big data employing fog computing. The authors developed a prototype of GeoFog architecture using Intel Edison and Raspberry Pi devices. The authors implemented some of the open source compression methods for reducing the data transmission overload in the cloud. Proposed architecture performs data compression and overlay analysis of data. The authors further discussed the improvement in scalability and time analysis using proposed GeoFog architecture and Geospark tool. Discussed results show the merit of fog computing that holds an enormous promise for enhanced analysis of geospatial big data in river Ganga basin and tourism information management scenario.

KEYWORDS

Cloud Computing, Geospatial Big Data, Geospatial Data, K-Means, Open Source GIS, Overlay Analysis, River, Tourism, Visualization

INTRODUCTION

Cloud computing-based GIS architecture has facilitated sharing and exchange of geospatial data belonging to various stakeholders. This cloud architecture has shaped an environment which has enabled different variety of users to access and retrieve geospatial data. It has also designed and implemented such a way that the geospatial data along with linked metadata has transmitted and

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used in secured manner (Chen et al., 2012; Brovelli et al., 2016a; Barik et al., 2017c). This cloud computing-based GIS architecture has leveraged for many applications i.e. environmental monitoring, urban planning, natural resource management, marine, coastal and healthcare management (Brovelli et al., 2016b). It has integrated with many geospatial database operations such as geospatial data visualization, overlay analysis, spatial queries and spatial statistical computations. These unique types of features are distinguished the cloud-based GIS architecture from other spatial decision support systems. It has been used numerous tools in public and private sector for predicting outcomes, explaining events, and various designing strategies (Barik. and Samaddar, 2014b; Brovelli et al., 2014; Georis-Creuseveau et al., 2016; Barik, 2017a; Coleman et al., 2016).

Geospatial data are stored numerous distributions and temporal data. In early traditional architecture of cloud-based GIS model, it has processed the data at cloud server (Yang et al., 2011; Huang et al., 2013; Yang, et al., 2017; Barik et al., 2016a). This type of system/scheme has required high internet bandwidth along with large processing time. Thus, by the using of the fog computing concept, it overcomes the large processing time problem by providing the computation overhead near the edge of client. Fog computing concept in cloud GIS architecture has the greatest enhancing capabilities by reducing the latency period as well as increased the throughput.

Raspberry Pi and Intel Edition are working as fog devices which are provided as low power gateway for implementing fog computing environment. These devices are used to reduce the latency as well as increase throughput at the edge of clients for numerous geospatial applications (Yang et al., 2010; Barik et al., 2016b; Dubey et al., 2017; Barik, 2017a). That architecture has the greatest potential for reduction of cloud storage for geospatial big data. It also helps to minimize the transmission power as it only used to send the desire results to the cloud rather than whole data for processing and analyzing. These fog devices are used as the middle ware between the cloud and edge of the clients. That gives rise to the improvement overall efficiency in data communications and analysis. Various types of fog enabled devices are working as the gateway or clients such as wearable sensor devices and mobile smart phones. The use of these devices led to the generation of huge amount of geospatial big data. Fog and cloud computing services can leverage these big data for assisting different kind of analysis.

It defines the concept of low resources machine learning on fog enabled devices which are kept closer to the smart devices. In traditional system, the different types of data processing and machine learning approaches are implemented at the cloud layer. Thus, for solving these problems, the present research paper proposes *GeoFog* architecture that relied on geospatial big data analysis on river Ganga basin and tourism information infrastructure management of temple city, Bhubaneswar, India. So, the geospatial big data have processed near the edge computing devices are being use for fog computing devices and are stored at the cloud computing layer. These are the following contributions are outlined in this research papers:

- It presents the concepts and architectural details of edge, cloud, fog computing and geospatial big data;
- It discusses about the proposed architecture of *GeoFog* and associated components which is responsible for processing geospatial data and spatial overlay analysis near the edge devices;
- There are two case studies i.e. Ganga river basin and tourism information management are explained with the use of *GeoFog* architecture;
- It elucidates the improvement of data scalability and time analysis in *GeoFog* architecture with the help of Geospark tool and some modification in fog layer module;
- It also gives the comparison outline of CloudGIS with proposed *GeoFog* architecture.

To achieve these objectives, an efficient fog computing based intelligent management system is proposed for real time monitoring and analysis of river Ganga basin and tourism information. In this research, it has used fog devices to collect the information near the edge of the devices. Then

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