Thesis Title: **Energy and Timeliness-Aware Geospatial Query Processing in Integrated Cloud-Fog-Edge Computing Environments**

Jaydeep Das, Roll No: 14AT92R04, Ph.D. Scholar, Advanced Technology Development Centre, Indian Institute of Technology Kharagpur (IIT Kharagpur), India

[Ph.D. Supervisors: **Prof. Soumya Kanti Ghosh**, CSE, IIT Kharagpur, India, and **Prof. Rajkumar Buyya**, CIS, University of Melbourne, Australia]

Abstract

In recent times, there is a growing need to analyse Spatio-temporal datasets to extract meaningful information and provide location-aware services, such as trip planning, weather forecasting, and even health management. From its inception, Spatio-temporal data mining has shown a significant impact on varied aspects of our lives. However, analysing a huge volume of Spatio-temporal datasets is challenging since it requires enormous computing and storage power and several spatial operations to perform analytics efficiently. In this regard, Cloud computing is undoubtedly the most feasible solution as it provides unlimited computing resources and data storage facilities. However, frequent communications with distant cloud servers increase the delay and may affect the Quality of Service (QoS) of any framework. Here, the fog or edge nodes can be made intelligent enough to analyse and adapt timely measures to reduce the intervention of cloud servers at each time. While fog or edge computing is not a replacement for cloud computing, the magnificent integration of these two booming technologies can efficiently facilitate delay, energy awareness, and real-time applications.

To be specific, our research focuses on exploring the spatial cloud computing domain to facilitate several real-life applications in less delay and energy consumption. The most critical aspect of facilitating any real-life application by analysing a large volume of data is to develop an efficient query processing module. The demand for computing resources to process the geospatial queries has been increased drastically. The query helps the users to get a variety of information to serve their needs. A huge number of heterogeneous data sources and different computing services are involved in resolving the geospatial queries. Extracting appropriate results within a specific time bound and orchestration among those data sources and web services are essential. These services are available on the web and require different resource specifications in order to resolve a geospatial query.

The major contributions of this thesis are (1) Development of a taxonomy for geospatial cloud-fog-edge computing environments. (2) Resolution of geospatial queries in the cloud with heterogeneous data sources. (3) Various geospatial queries resolve in cloud platform after generating geospatial service chaining. Pre-estimating the cloud resources helps provide resources to geospatial queries within user-defined budget and time deadline using a game theory-based approach. (4) Geospatial query resolution within region-specific fog devices. It is an energy-efficient and delay-aware geospatial query resolution framework. (5) Finally, a real-time healthcare service provisioning with geospatial queries in a cloud-fog-edge integrated platform. It is an energy and latency-aware framework, leading to a green geospatial query resolution platform. We have also performed an extensive comparative study with the benchmark and state-of-the-art spatial cloud computing systems, demonstrating our proposed spatial cloud-based methods' efficacy and superiority. The overall study comprises collection, orchestration, analysis, and visualization of Spatio-temporal data sources, such as road-networks, land-use information, location-based movement patterns, and user health profiles at different spatial locations at various time-scales.

Keywords: *Spatial Cloud Computing, Geospatial Query, Geospatial Services, Fog Computing, Edge Computing.*

****