B.Tech 2020-24 CSE- Project Phase 1

Proposal

I. Group No.:CAB4

Project Title.: Adaptive Δ-Stepping Algorithm for Communication-Efficient Distributed Computing in Heterogeneous and Mobile Environments

Team members : GOURINATH [AM.EN.U4CSE20129]

KARTHIK PRASAD [AM.EN.U4CSE20240]

II. Abstract

The project aims to enhance the Δ-stepping algorithm for communication-efficient distributed computing in heterogeneous and mobile environments. The main problem to be addressed is the lack of effective algorithms that can adapt to the varying hardware configurations, processing capabilities, and node mobility in real-world distributed systems. The relevance of this problem lies in the prevalence of such diverse environments in modern computing scenarios. The motivation for the project is to develop a robust and scalable algorithm that efficiently handles node heterogeneity, mobility, and dynamic network changes. The persisting challenges involve devising adaptive strategies for computation and communication decisions and handling node migrations without disruptions in computation progress. The project seeks to contribute to more efficient and adaptable distributed computing systems with practical applications in various domains.

III. Background Study

Title & year	Problem	Contributions	Limitations	Open problems/Future work
1.Communication-Efficient Δ-Stepping for Distributed Computing Systems Date of Conference: 21-23 June 2023 Publisher: IEEE	The problem identified in this paper is the lack of efficient single source shortest path (SSSP) algorithms designed for distributed computing systems, especially in the context of diverse smart devices with limited computing resources. The existing SSSP algorithms are mostly designed for shared-memory systems, and when deployed on distributed networks, communication delay becomes a significant performance bottleneck.	Introducing a communication-efficient Δ-stepping algorithm for distributed computing systems, featuring a master-slave architecture to reduce message exchanges and two edge relaxation methods (pruning and aggregation) to speed up computation.Presenting a switching mechanism that allows combining the two edge relaxation methods to achieve communication-efficiency tradeoff.Demonstrating through theoretical analyses and experimental studies on real-world graph datasets the promising performance of the proposed algorithm compared to existing methods, particularly in scenarios with	The limitations found in this paper are the lack of exploration of the proposed Δ-stepping algorithm's performance in highly dynamic and mobile environments and its scalability on large-scale graphs. Additionally, the impact of communication delay in wireless networks has not been extensively studied, which could affect the algorithm's efficiency and practicality in such scenarios.	1.Heterogeneous and Mobile Computing Nodes 2.Parallelization and Communication Efficiency 3.Energy Efficiency in Smart Devices 4.Wireless Environment Testing

		varying communication delay and graph density.		
2.EdgeIoT: Mobile Edge Computing for the Internet of Things Date of Publication: 16 December 2016 Publisher: IEEE	The traditional Internet of Things (IoT) architecture faces scalability issues due to high-volume data streams transmitted to the remote cloud. To address this, the article proposes edgeIoT, a mobile edge computing approach using fog nodes and SDN-based cellular cores. It aims to handle data streams locally, reduce core network traffic, and maintain user privacy. However, challenges include handling massive IoT data, real-time data processing, and ensuring user privacy.	The article proposes edgeIoT, a novel mobile edge computing architecture for the Internet of Things (IoT). It brings computing resources close to IoT devices to reduce core network traffic and end-to-end delay. The hierarchical fog computing architecture allows flexible and scalable resource provisioning. A proxy VM migration scheme is also introduced to minimize core network traffic. The article's contributions include efficient handling of IoT data streams, reduced traffic load, and potential solutions to challenges in implementing edgeIoT. The paper presents a comprehensive survey on Mobile	The limitations of the proposed edgeIoT architecture are not explicitly mentioned in the provided text. Further examination of the article may be required to identify any potential drawbacks or challenges that the proposed architecture may have.	1.Scalability and Performance 2.Security and Privacy 3.Real-world Deployment and Practicality 4.Interoperability and Standardization

3.Mobile Edge Computing: A Survey Date of Publication: 08 September 2017 Publisher: IEEE	The paper presents a comprehensive survey on Mobile Edge Computing (MEC), an emergent architecture that extends cloud computing services to the edge of networks. It explores the definition, advantages, architectures, applications, and research challenges of MEC, with a focus on its potential to offer bandwidth, battery life, and storage to resource-constrained mobile devices, especially in 5G networks.	Edge Computing (MEC), an emergent architecture that extends cloud computing services to the edge of networks using mobile base stations. MEC aims to address the challenges of traditional mobile cloud computing, such as high latency and low coverage. The survey covers various aspects of MEC, including its definition, advantages, architectures, application areas, research trends, research infrastructures (MEC testbeds), security and privacy issues, and open research challenges. The paper highlights MEC's potential in providing elastic resources and supporting computational-intensive tasks with ultralow latency, especially in 5G networks. It emphasizes MEC's	The paper may focus on specific aspects of MEC, leaving out other relevant areas or technologies related to edge computing.As the field of MEC is rapidly evolving, the paper may not capture all the latest advancements and research findings.	1.Scalability and Interoperability 2.Resource Management and Optimization 3.Security and Privacy Enhancements

		role in building an ecosystem involving various stakeholders and mobile operators.		

IV. Challenges

1. Adapting to Heterogeneous Environments: Devising algorithms that can effectively utilizethe varying hardware capabilities and processing power of nodes in a heterogeneous environment is challenging. The algorithm needs to allocate tasks optimally to nodes with different computing resources, ensuring efficient resource utilization.

2.Handling Node Mobility: In a mobile environment, nodes may join or leave the network or change their locations dynamically. Managing node mobility and ensuring continuous computation progress despite node movements require sophisticated strategies to track node status and handle data migration effectively.

3.Dynamic Network Changes: The distributed system may experience changes in the network topology due to node mobility or connectivity fluctuations. The algorithm needs to adapt to such changes to maintain data consistency and efficient communication between nodes.

V. Deliverables of Phase I

Objective 1: Literature Review and Problem Analysis

Conduct a comprehensive literature review on Δ-stepping algorithms, distributed computing, and related research in the context of heterogeneous and mobile environments.

Analyze the challenges and requirements for efficiently handling the single source shortest path (SSSP) problem in such distributed systems.

Objective 2: Algorithm Design and Prototyping

Design an adaptive Δ-stepping algorithm that dynamically adjusts computation and communication strategies based on node heterogeneity and mobility.

Create a prototype of the algorithm, focusing on the core components of the master-slave architecture and initial message coordination.

Objective 3: Implementation of Message Coordination

Implement the message coordination architecture for minimizing message exchanges between computing nodes.

Develop basic communication protocols and data structures required for task distribution and synchronization

Outcomes/Deliverables

Improved Communication Efficiency: The enhanced Δ-stepping algorithm is expected to reduce communication overhead in the distributed system. By efficiently managing the exchange of information between nodes, the algorithm can minimize message delays and network congestion, leading to improved overall system performance.

Adaptability to Diverse Environments: The project aims to create an algorithm that can adapt to heterogeneous and mobile environments. As a result, the distributed system will be able to efficiently utilize the varying hardware capabilities and processing power of nodes and handle node mobility and dynamic network changes seamlessly.

Enhanced Robustness and Scalability: The algorithm's adaptability and optimized resource allocation are likely to contribute to increased robustness and scalability of the distributed system. It will be able to handle a larger number of nodes and tasks while maintaining efficient computation progress.

VI. Assumptions/Declarations:

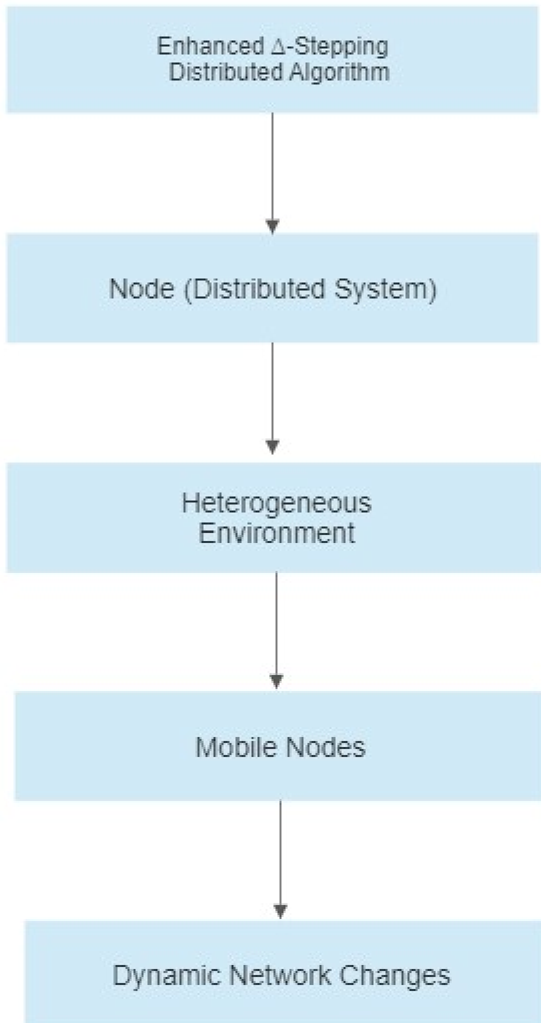
Homogeneous Task Execution: The project assumes that each task or computation in the distributed system can be executed by any node in the network without significant variations in performance. In other words, the algorithm does not explicitly consider tasks that require specialized hardware or specific node capabilities.

Synchronized Clocks: The project assumes that the clocks of the nodes in the distributed system are synchronized or that the time differences between nodes' clocks are negligible. This assumption is often made in distributed computing to simplify timestamp-based algorithms and coordination mechanisms.

VII. Tools to be used

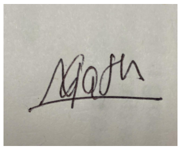
Software/Hardware Tools	**Specifications**
1. Programming Language 2. Distributed Computing Libraries: 3. Graph Processing Libraries 4. Simulation and Testing Tools 5. Development Environment 6. Data Visualization Tools	1. Python or C++ 2. Apache Hadoop,Apache Spark 3. GraphX 4. Network Simulation Tools 5. IntegratedDevelopment Environment 6. Matplotlib (for Python)

VIII. High Level Design

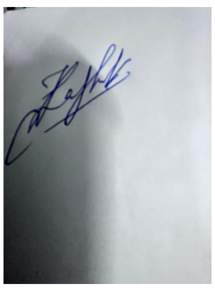


Students' Name and Signature

GOURINATH



KARTHIK PRASAD



Guide's Signature

SABITHA S