Sustainable Edge Computing Paradigm Assisted Architecture for Real-Time E-Challan Application

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ABSTRACT

These days, the usage of real-time applications has been increasing progressively in smart cities like Karachi. The applications, such as E-Challan, and monitoring at widely deployed across the Karachi smart cities at different road signals. The existing smart cities, like Karachi based on a cloud computing environment, which incurs huge end-to-end time for data collection and processing. For instance, collecting more than 5 million vehicle data in terms of multimodal such as images, videos, and more are critical challenge in a cloud computing-based environment for cities like Karachi. In this paper, we present a sustainable edge computing paradigm-enabled architecture to provide a sustainable and collaborative environment for the execution and collection of real-time data without any scalability issues. The real-time data, such as video, images, and more, are collected from different signals as input, which are placed and implemented in the edge nodes, and offload their data to the centralized edge controller for processing. We conducted the different testbed experiments at a local research laboratory and improved the performance of real-time applications by 10%, reduced latency by 30% and reduced resource consumption by 20%.

Keywords: Sustainability, Edge Computing, Real-Time Systems, Distributed Architecture, AI-driven Scheduling.

INTRODUCTION

These days, the growing advancement in IoT and real-time applications for various domains has compelled to ensure the development of various computing paradigms that are capable and efficient to handle and manage the drastic data flows within a short period of time without delay and by utilizing the least energy for the performance of tasks [1-2]. As per available traditional cloud-based frameworks, which mostly become unable to accomplish the requirement of real-time decision making due to reasons like delays in transmission and other issues of centralized frameworks in nature [3].

PROBLEM STATEMENT

These days, the usage of real-time applications has been increasing progressively in smart cities like Karachi. The applications, such as E-Challan, and monitoring at widely deployed across the Karachi smart cities at different road signals. However, collecting more than 5 million vehicle data points and processing them are the critical challenges in smart cities. The existing systems are widely deployed on cloud computing and suffer from many latencies and resource consumption issues and support the real-time workload decision of vehicle data in smart cities [4-5].

OBJECTIVES

1. In this paper, we suggest a Sustainable Edge computing paradigm.
2. To meet the real-time requirements of the application, the paradigm has different scheduling methods.
3. We consider the delay constraints that reduce the end-to-end latency of real-time applications.

4. To implement Quality of Service-based scheduling of resources across distributed edge nodes.

ARCHITECTURE

In this paper, we present the distributed sustainable edge computing networks that consist of homogeneous edges, and they work in collaboration and share all data on the edge controller, as shown in Figure **1**.

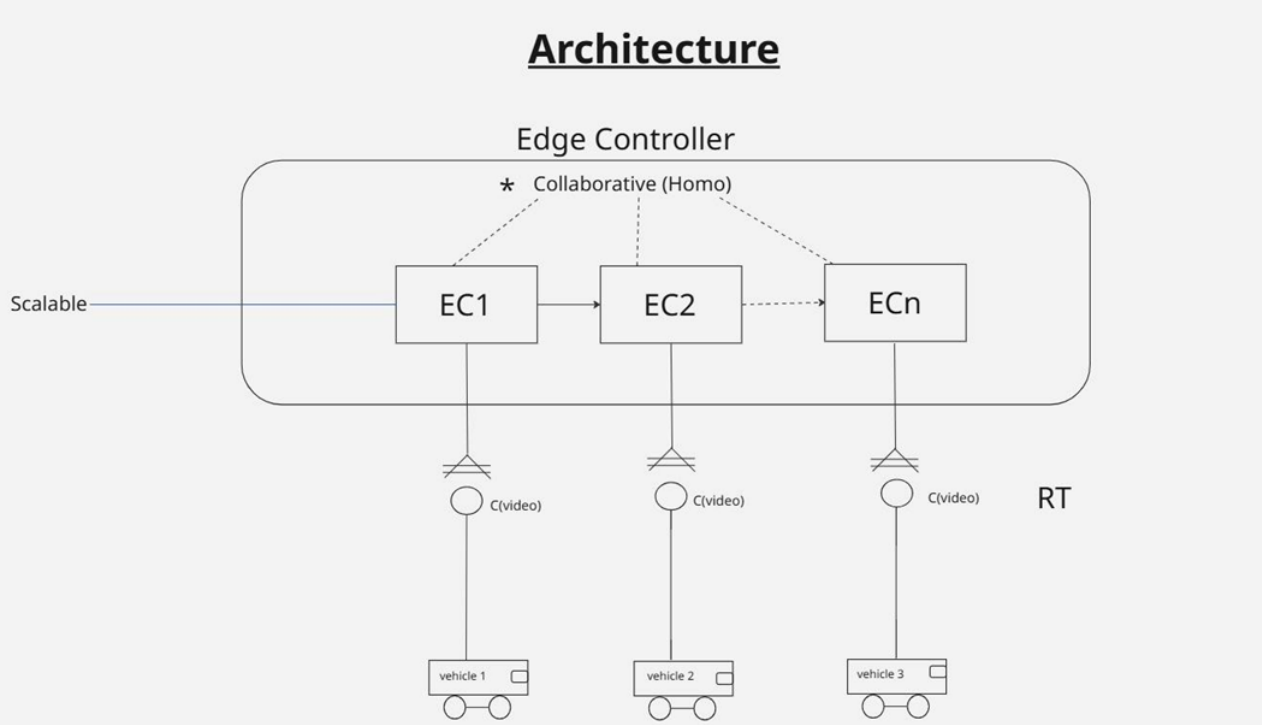


Figure 1. Proposed sustainable edge cloud computing paradigm for real-time e-chalan vehicle application.

We consider the real-time application, such as the E-chalan of vehicles when they are roaming on the road-unit side to control the traffic violence in the smart city Karachi. We consider the data, such as collecting videos or images from different edge nodes, which are placed at the road-unit side in smart cities in Karachi.

RESULT

We are conducting test-bed experiments on the collected data from the local laboratories to make the entire E-challan application a more sustainable environment based on the proposed edge computing paradigm. We design architecture based on different strategies, such as federated learning and training on each node and sharing with the aggregated node for decision-making and storage. Our focus is to reduce the end-to-end time for data collection. While every vehicle stays at the signal for 90 seconds, we can monitor road violence if that happens in smart cities.

We conducted experiments based on the generated synthetic data on 5 million and generated their E-chalan for Karachi Smart City, as shown in Figure **2**. We assumed that more than 5000 cameras are deployed at the road unit side, generated by edge nodes, and decisions are made by the edge controller and sent to the customer portal with minimal end-to-end delay.

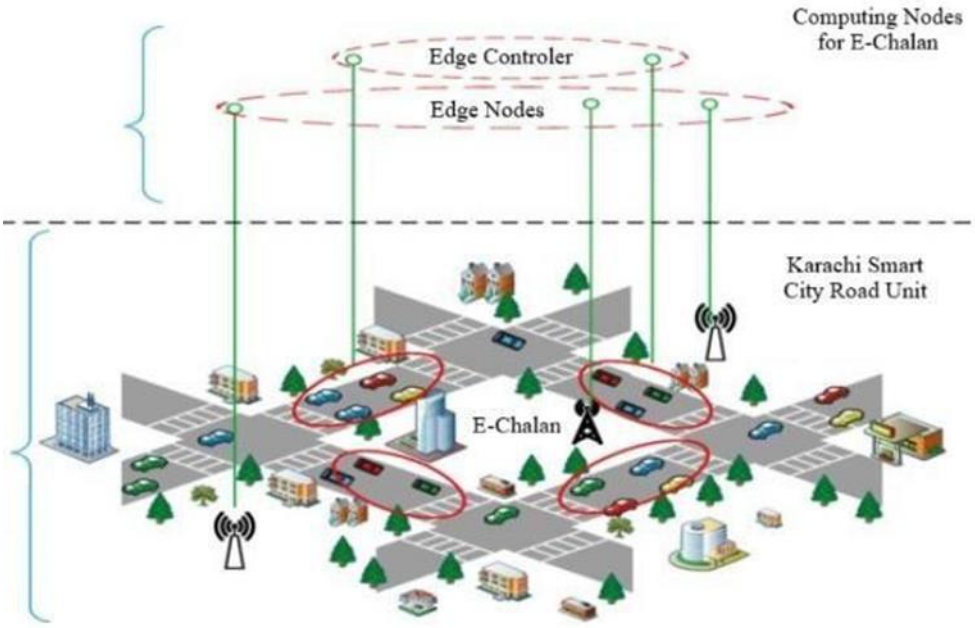
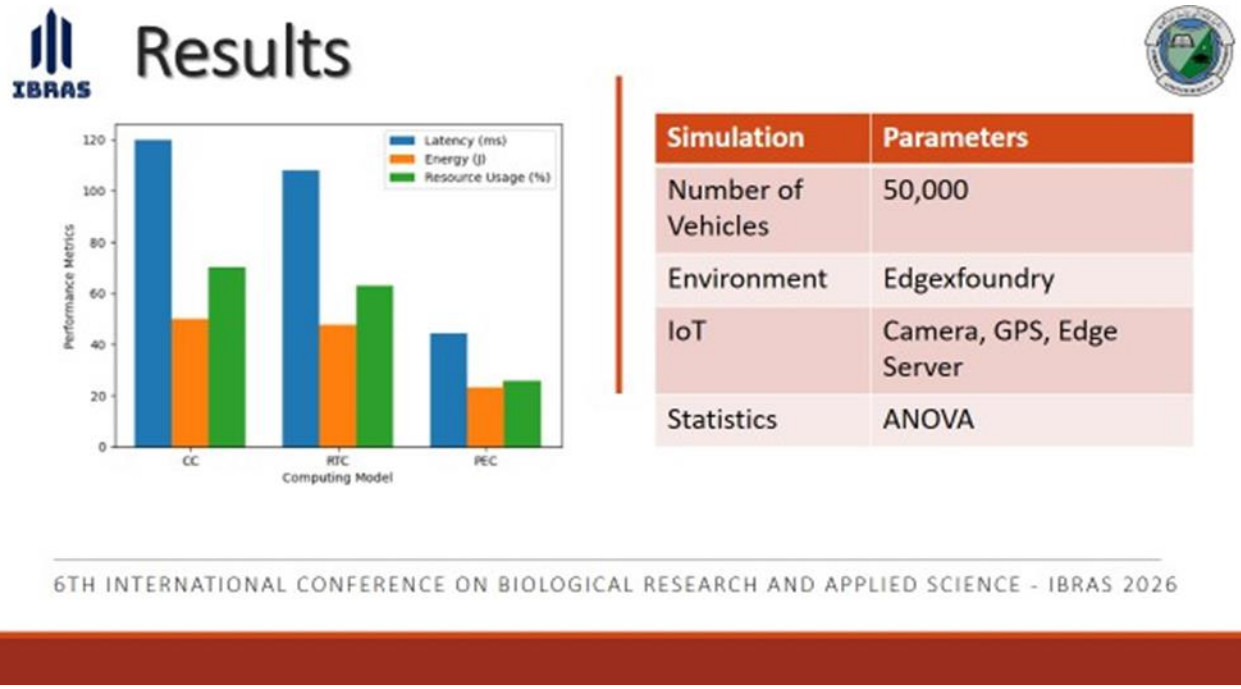


Figure 2. Testbed experiments of the simulation.



CONCLUSION

In this paper, we presented the smart city paradigm for the E-chalan system for Karachi Smart City and generated the E-chalan in real-time with minimum end-to-end latency and minimum resource consumption.

In future work, we will address the security concerns in this environment and implement federated learning for collaborative learning into the system.

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