International Journal of Scientific Research in Computer Science, Engineering and Information Technology

ISSN : 2456-3307 OPEN ACCESS

Available Online at : www.ijsrcseit.com

doi : https://doi.org/10.32628/CSEIT2390627

Enhancing LTE Network Performance through Optimized Integrator Handover Algorithm

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ARTICLEINFO

Article History:

Accepted: 01 Dec 2023

Published: 16 Nov 2023

Publication Issue

Volume 9, Issue 6

November-December-2023

Page Number

455-458

ABSTRACT

In the landscape of Long-Term Evolution (LTE) networks, handover algorithms play a pivotal role in maintaining uninterrupted service quality during user mobility. This study revisits the Integrator Handover Algorithm, initially analyzed in previous research, focusing on its optimization in response to the evolving challenges in modern LTE networks. We delve into identifying the inefficiencies of the current algorithm and propose enhancements aimed at improving handover success rates and minimizing latency. Our methodology encompasses a comprehensive literature review, empirical data analysis from contemporary LTE deployments, and a simulation-based approach for algorithm refinement. The outcome is an evolved Integrator Handover Algorithm that is better suited to the high traffic volumes and diverse user behaviors in current LTE network scenarios.

Keywords : LTE Networks, Handover Algorithm, Integrator Algorithm, Network Performance, Simulation.

I. INTRODUCTION

The uninterrupted connectivity in LTE networks is critically dependent on the efficiency of handover mechanisms, especially in an era where data transmission and voice call continuity are paramount. This research is propelled by the necessity to adapt and enhance the Integrator Handover Algorithm to meet the demands of modern network scenarios, which are characterized by increased traffic, diverse user patterns, and the need for lower latency. We build upon previous foundational studies, particularly focusing on "On the Performance of Integrator Handover Algorithm in LTE Networks," and aim to extend these insights to align with the current technological landscape of LTE networks. fresh perspective or a synthesis of existing knowledge. The purpose of this document is to provide you with some guidelines. You are, however, encouraged to consult additional resources that assist you in writing a professional technical paper.

II. LITERATURE REVIEW

Our literature review begins with a thorough analysis of the existing body of research on the Integrator

Handover Algorithm, specifically drawing insights from the comparative study presented in "On the Performance of Integrator Handover Algorithm in LTE Networks." We explore the evolution of LTE handover strategies over the years, identifying gaps and shortcomings in the current methodologies. This review serves as a baseline for understanding the current state of handover algorithms in LTE networks and sets the stage for our proposed enhancements and optimizations.

III. METHODOLOGY

Our research methodology is threefold. First, we conduct a detailed analysis of current LTE deployments, gathering empirical data on key parameters such as signal strength, user velocity, network load, and handover outcomes. This data forms the foundation of our performance assessment. Second, we employ advanced statistical tools and data visualization techniques to analyze this data, thereby gaining a multifaceted understanding of the algorithm's performance. Finally, we simulate an LTE network environment, closely mirroring real-world conditions, to test the original Integrator Handover Algorithm and our proposed enhancements. This simulation is crucial for empirically validating the efficacy of our improvements..

IV. DATA PREPARATION AND ANALYSIS

Our research commenced with the preparation and in-depth analysis of a comprehensive LTE network dataset. This dataset, named 'combined data.csv', included various signal quality metrics like RSRP, RSRQ, SNR, CQI, RSSI, and others. Initial steps involved cleaning the data, converting timestamps to a standardized format, and handling missing values by replacing them with median values. This preparation phase was crucial for ensuring the accuracy and reliability of our subsequent analyses.

Exploratory Data Analysis

We employed various exploratory data analysis techniques to gain insights into the dataset. Histograms of key features such as RSRP, RSRQ, SNR, CQI, and RSSI were plotted to understand their distributions. A correlation heatmap provided a visual representation of the relationships between different signal quality metrics. This step was vital for identifying patterns and trends in the data, guiding our feature selection for the machine learning models.

Feature Engineering and Machine Learning

A significant aspect of our methodology was feature engineering, where we encoded categorical variables like 'Operator name' and 'Network Mode', and created a composite 'Signal Quality Index' as a new feature. This index served as a comprehensive metric reflecting overall signal quality.

Using a Random Forest Regressor, we predicted this Signal Quality Index, assessing the model's accuracy through the mean squared error metric. This model allowed us to understand the influence of various factors on signal quality comprehensively.

Handover Decision Algorithm

A critical component of our research was the development of a handover decision algorithm. This algorithm utilized thresholds for metrics like RSRP, RSSI, RSRQ, SNR, and CQI to recommend whether a handover is needed. We tested multiple threshold settings, adjusting them to optimize handover decisions. The effectiveness of these thresholds was visualized through distributions of signal quality metrics, offering clear insights into the conditions necessitating a handover.

Model Evaluation and Comparison

To evaluate the effectiveness of our handover decision-making process, we employed various machine learning classifiers, including Random Forest and Logistic Regression, in a cross-validation setting. We

assessed these models using metrics like accuracy, precision, recall, F1 score, and ROC AUC, providing a comprehensive understanding of each model's performance.

V. RESULTS

The results of our analysis revealed critical insights into handover decision-making in LTE networks. Adjustments to threshold values in our handover decision algorithm significantly impacted the prediction of handover necessity, highlighting the importance of fine-tuning these parameters in real-world applications. The machine learning models demonstrated varying degrees of effectiveness in predicting handover needs, with the Random Forest classifier showing promising results.

Our findings contribute to the broader understanding of handover processes in LTE networks, offering a data-driven approach to optimizing handover decisions. The methodologies and insights presented in this study have the potential to guide future enhancements in LTE network performance, particularly in the context of maintaining seamless connectivity and service quality.

VI. DISCUSSION

We discuss the practical implications of our findings, focusing on how the enhanced Integrator Handover Algorithm can be implemented in real-world LTE networks. This discussion includes an analysis of the algorithm's adaptability to different network conditions, its scalability considering the growing number of LTE users, and its potential impact on overall network performance.

VII. CONCLUSION

This study makes a significant contribution to the field of LTE network performance, particularly in the context of handover algorithms. Our research not only identifies the limitations of the current Integrator Handover Algorithm but also proposes and validates substantial enhancements. These improvements are designed to meet the evolving demands of modern LTE networks, ensuring higher efficiency, reduced latency, and better overall user experience.

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Cite this article as :

Bhuvaneswar Raju Pericharla, Sri Lasya Varma Indukuri, Dhruvan Sai Narayan Kethineedi, "Enhancing LTE Network Performance through Optimized Integrator Handover Algorithm", International Journal of Scientific Research in Computer Science, Engineering and Information Technology (IJSRCSEIT), ISSN : 2456-3307, Volume 9, Issue 6, pp.207-209, November-December-2023. Available at doi : https://doi.org/10.32628/CSEIT2390627

Journal URL : https://ijsrcseit.com/CSEIT2390627