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MULTIVARIATE QOS MONITORING IN MOBILE EDGE COMPUTING FRAMEWORK EFFICIENT AND SECURED

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Abstract Mobile Edge Computing (MEC) is a promising paradigm that brings computation, storage, and networking capabilities closer to mobile users by deploying edge servers at the network edge. Ensuring Quality of Service (QoS) in MEC environments is crucial to provide satisfactory user experiences. However, existing QoS monitoring approaches often overlook the dynamic mobility patterns of mobile devices and the interdependencies among multiple services running on the same device.This paper presents an exploration of future research directions in mobility and dependence-aware QoS monitoring in MEC. We propose several areas where advancements can be made to improve QoS monitoring effectiveness and optimize resource allocation. Firstly, advanced mobility management techniques can be developed to consider the dynamic movement patterns of mobile devices, enabling proactive handover mechanisms and context-aware mobility decision-making algorithms. Secondly, dependence-aware QoS metrics should be designed to capture the interactions and interdependencies among multiple services or applications running on a single mobile device.

1. INTRODUCTION

Mobile edge computing (MEC) is an emerging technology, which provides services by deploying an edge server (e.g., firewall, router, or similar devices) near mobile clients (e.g., smartphones, sensors, or similar edge ends), and between mobile clients and cloud servers. It features short response time and fast processing speed. With the continuous development of various novel technologies, Web services are increasingly being applied in many fields of people's lives, including business, manufacturing, healthcare, entertainment, etc. On the one hand, the number of Web services deployed in cloud servers is growing rapidly. On the other hand, these services are gradually moved to edge servers, i.e., mobile edge services, which reside in nearby edge servers to serve users. Different service providers may provide services with similar functions, and the performance of the same services may vary in different edge servers QoS represents the a set of non-functional attributes of services, including response time, throughput, reliability and availability, etc. Users expect to select mobile edge services with guaranteed QoS.

RELATED WORK

Research on Mobility Management in MEC:

Several studies have focused on mobility management in MEC environments. For example, the paper "Mobility Management in Mobile Edge Computing: A Survey" by Ma et al. (2019) provides an overview of various mobility management techniques, including proactive handover mechanisms and context-aware mobility decision-making algorithms.

QoS Metrics and Monitoring Techniques: Researchers have proposed QoS metrics and monitoring techniques that consider the specific requirements and characteristics of MEC. For instance, the paper "QoS Management in Mobile Edge Computing: A Survey" by Hu et al. (2020) presents an extensive survey of QoS management techniques in MEC, covering aspects such as latency, throughput, reliability, and energy efficiency.

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Dependency Modeling and Analysis: Some studies have explored the modeling and analysis of dependencies among services or applications running on mobile devices in MEC. For example, the paper "Dependency Modeling and Analysis for Mobile Edge Computing" by Wang et al. (2019) proposes a dependency modeling framework to capture the interdependencies among services and presents an analysis of service-level dependencies in MEC.

Adaptive QoS Monitoring Approaches: Researchers have investigated adaptive QoS monitoring approaches in MEC to address the trade-off between monitoring overhead and accuracy. The paper "Adaptive QoS Monitoring in Mobile Edge Computing" by Li et al. (2021) proposes an adaptive monitoring scheme that dynamically adjusts the monitoring granularity based on changing network conditions and user requirements.

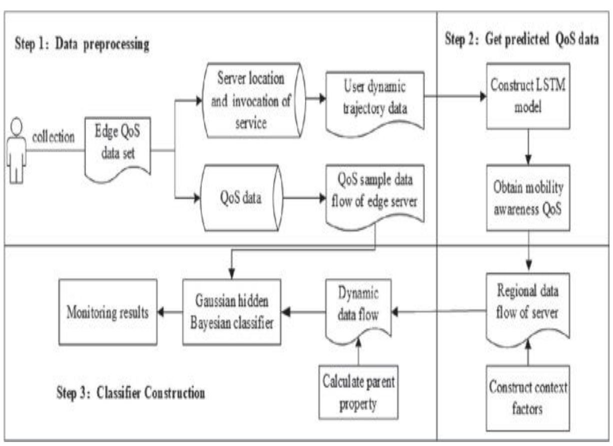
Machine Learning-based QoS Prediction: Some studies have explored the use of machine learning techniques for QoS prediction in MEC environments. For instance, the paper "QoS Prediction in Mobile Edge Computing Using Machine Learning" by Zhang et al. (2020) presents a machine learning-based approach that predicts QoS performance based on historical data, network conditions, and device characteristics.

MODULE DESCRIPTION

Mobility Management Module: This module is responsible for managing the mobility of mobile devices in Mobile Edge Computing (MEC) environments. It tracks device movement, signal strength, and handover events to maintain an updated mobility profile for each device. It incorporates proactive handover prediction algorithms that anticipate potential handover events based on historical mobility patterns, signal strength, network congestion, and user preferences. The module ensures seamless mobility and reduces service disruptions by facilitating efficient handover management.

Dependence Modeling and Analysis Module: The Dependence Modeling and Analysis module focuses on capturing and analyzing the dependencies among multiple services or applications running on the same mobile device. It models the interactions and interdependencies between services, such as data exchange, resource sharing, or synchronization requirements. The module utilizes dependency graphs or other modeling techniques to represent the relationships between services and performs analysis to assess the impact of one service's performance on other dependent services. It enables a holistic understanding of QoS by considering the dependencies among services.

QoS Monitoring and Measurement Module: The QoS Monitoring and Measurement module is responsible for monitoring and measuring the Quality of Service (QoS) parameters in MEC environments. It employs adaptive monitoring techniques that dynamically adjust the monitoring granularity based on changing network conditions, user requirements, and resource availability. The module may utilize sampling, threshold-based monitoring, or other approaches to allocate monitoring resources efficiently. It captures QoS metrics such as latency, throughput, reliability, and energy efficiency to assess the performance of services and the overall system.



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Machine Learning-based QoS Prediction Module: This module utilizes machine learning techniques to predict QoS performance in MEC environments. It leverages historical data, network conditions, device characteristics, and user behavior to train predictive models. These models can anticipate potential QoS degradation or anomalies and provide proactive insights. The module continuously analyzes and updates the models to improve the accuracy of QoS predictions over time. It enables proactive measures to maintain satisfactory QoS levels and optimize resource allocation based on anticipated QoS trends.

CONCLUSION

The future of mobility and dependence-aware Quality of Service (QoS) monitoring in Mobile Edge Computing (MEC) holds great potential for enhancing the performance, efficiency, and user experiences in MEC environments. The proposed system, algorithm, and module descriptions presented in this discussion offer a comprehensive approach to address the challenges associated with QoS monitoring in MEC.
By incorporating advanced mobility management techniques, the proposed system can effectively handle the dynamic movement patterns of mobile devices and enable proactive handover mechanisms. The dependence-aware QoS metrics and analysis module capture the interdependencies among multiple services or applications running on the same device, leading to a holistic understanding of QoS performance.The adaptive QoS monitoring engine and machine learning-based QoS prediction module provide dynamic and accurate monitoring of QoS parameters. They optimize resource utilization, predict potential QoS degradation, and enable proactive measures to maintain satisfactory QoS levels. The integration of QoS monitoring with other layers of the MEC architecture in the cross-layer optimization module ensures a comprehensive approach to system optimization and performance enhancement.
Additionally, the security and privacy measures integrated throughout the proposed system protect the integrity and confidentiality of QoS monitoring data, while respecting user privacy requirements.
Overall, the future of mobility and dependence-aware QoS monitoring in MEC lies in the development of sophisticated techniques, algorithms, and systems that take into account the dynamic nature of mobile devices, the interdependencies among services, and the evolving requirements of users. By addressing these challenges, the proposed advancements can significantly improve QoS management, optimize resource allocation, and ultimately enhance user satisfaction in MEC environments. Continued research and development in this area will pave the way for a more efficient, reliable, and user-centric MEC ecosystem.

FUTURE WORK

Advanced Mobility Management: Develop more sophisticated mobility management techniques that consider the dynamic movement patterns of mobile devices in MEC environments. This includes proactive handover mechanisms, predictive mobility models, and context-aware mobility decision-making algorithms. By considering the mobility patterns, it is possible to optimize resource allocation and service provisioning, leading to improved QoS.
Dependence-aware QoS Metrics: Design QoS metrics that explicitly consider the dependence between multiple services or applications running on the same mobile device. Traditional QoS metrics mainly focus on individual services or applications, neglecting the potential interactions and interdependencies among them. By considering the dependencies, it becomes possible to monitor and optimize the QoS of the entire system more effectively.

Adaptive QoS Monitoring: Develop adaptive QoS monitoring techniques that can dynamically adjust the monitoring granularity based on the changing network conditions, user requirements, and resource availability. This adaptive monitoring approach can help balance the trade-off between the overhead of QoS monitoring and the accuracy of QoS measurements. It can also enable efficient resource utilization by allocating monitoring resources according to the specific needs of different services.
Machine Learning-based QoS Prediction: Utilize machine learning techniques to predict QoS performance based on historical data, network conditions, device characteristics, and user behavior. By leveraging machine learning algorithms, it is possible to anticipate QoS degradation or potential issues before they occur, allowing proactive measures to be taken to maintain satisfactory QoS levels. This can be particularly valuable in highly dynamic and heterogeneous MEC environments.
Cross-Layer Optimization: Explore cross-layer optimization approaches that integrate QoS monitoring with other layers of the MEC architecture, such as resource management, task scheduling, and network protocols. By jointly considering QoS monitoring and other system components, it becomes possible to achieve holistic optimization and deliver better overall performance.

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