PREDICTIVE MIGRATION OF SERVICE FUNCTION CHAINS FOR FAULT TOLERENT MOBILE EDGE COMPUTING

ABSTRACT

The exponential growth of connected devices and real-time applications has increased the demand for reliable, low-latency computation at the network edge. Mobile Edge Computing (MEC) has emerged as a critical paradigm that brings computing capabilities closer to end users, minimizing communication delays and reducing network congestion. However, fault tolerance and service continuity remain significant challenges, particularly when edge servers fail or become overloaded. This study presents a predictive migration model for Service Function Chains (SFCs) designed to ensure continuous operation in fault-prone mobile edge environments. The proposed approach employs machine learning techniques to forecast potential node failures and proactively migrate SFCs to healthy nodes before service degradation occurs. By integrating prediction models with dynamic orchestration, the system achieves efficient resource utilization, minimal downtime, and improved service reliability. Experimental evaluations demonstrate that the proposed framework reduces migration delay and service interruption compared to traditional reactive models, establishing a foundation for resilient and adaptive edge computing infrastructures.

Keywords: Mobile Edge Computing, Service Function Chain, Fault Tolerance, Predictive Migration, Machine Learning, Reliability.

EXISTING SYSTEM

Existing systems in fault-tolerant mobile edge computing primarily rely on reactive recovery mechanisms that initiate service migration only after a failure occurs. These systems detect node faults through continuous monitoring of performance metrics and trigger reallocation of VNFs and SFCs to backup nodes. While functional, this reactive approach introduces significant downtime, leading to service interruptions and degraded user experience. In highly dynamic environments where time-sensitive applications are deployed, such latency can severely impact reliability.

Additionally, static allocation models and threshold-based mechanisms used in conventional fault tolerance strategies are inadequate for managing unpredictable workloads. They lack the capability to anticipate failures, causing inefficient utilization of resources and unnecessary migrations. Furthermore, the reliance on centralized control planes introduces single points of failure and scalability issues in large, distributed MEC infrastructures.

Disadvantages of the Existing System

1. **Reactive Response to Failures:**

Migration occurs only after faults are detected, leading to unavoidable service disruptions and higher recovery time.

2. **Poor Resource Optimization:**

Static allocation policies cause underutilization of resources and inefficient SFC management during dynamic workload fluctuations.

3. **Limited Scalability and Predictive Capability:**

Centralized fault management lacks foresight, hindering the system's ability to handle large-scale edge deployments with evolving failure patterns.

PROPOSED SYSTEM

The proposed predictive migration framework introduces a machine learning-based model for fault-tolerant SFC management in MEC environments. The system proactively identifies potential node failures using time-series forecasting of performance metrics such as CPU usage, latency, and packet loss. Once a potential failure is predicted, the orchestration layer initiates migration of the affected SFCs to stable nodes, minimizing downtime and ensuring service continuity.

The architecture comprises three core modules: the Prediction Engine, SFC Orchestrator, and Migration Controller. The Prediction Engine utilizes recurrent neural networks (RNN) and adaptive learning algorithms to detect early failure signals. The SFC Orchestrator dynamically selects alternative nodes based on resource availability, network conditions, and service latency requirements. Finally, the Migration Controller performs stateful migration of VNFs with minimal overhead, ensuring seamless transition and minimal data loss.

Additionally, the system integrates mobility awareness by analyzing user trajectory patterns to prevent service interruptions during handovers. The machine learning model continuously refines its predictions through online learning, improving accuracy as new data is collected. This adaptability ensures long-term efficiency and robustness, making it suitable for diverse applications ranging from autonomous vehicles to industrial IoT systems.

Advantages of the Proposed System

1. **Proactive Fault Management:**

Anticipates node failures in advance using predictive analytics, enabling seamless migration and minimizing downtime.

2. **Efficient Resource and Service Orchestration:**

Dynamically allocates SFCs based on real-time conditions, ensuring optimal utilization and maintaining low latency.

3. **Enhanced Scalability and Adaptability:**

Supports distributed fault prediction and mobility-aware SFC management, providing resilience in large-scale, heterogeneous MEC environments.

SYSTEM REQUIREMENTS

- **H/W System Configuration:-**
- Processor - Pentium –IV
- RAM - 4 GB (min)
- Hard Disk - 20 GB
- Key Board - Standard Windows Keyboard
- Mouse - Two or Three Button Mouse
- Monitor - SVGA

SOFTWARE REQUIREMENTS:

- **Operating system** : Windows 7 Ultimate.
- **Coding Language** : Python.
- **Front-End** : Python.
- **Back-End** : Django-ORM
- **Designing** : Html, css, javascript.
- **Data Base** : MySQL (WAMP Server).