Seamless 6G Connectivity: AI-Based Handover Mechanisms for Hybrid Satellite-Terrestrial Networks

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***Extended Abstract*—With the rise of 6G networks, ensuring seamless and reliable connectivity in dynamic, mobile environments has become a major challenge. Traditional handover and resource management methods fall short under ultra-low latency demands and complex hybrid satellite-terrestrial setups. This research proposes an AI-driven framework using Deep Reinforcement Learning and Transfer Learning to enable intelligent handovers and adaptive resource allocation, ensuring low-latency, energy-efficient performance for critical 6G applications.**

To support delay-sensitive services in dynamic 6G environments, recent research introduced a caching-enabled MEC architecture combining martingale theory with Deep Reinforcement Learning. By using a Dynamic Request Aware Soft Actor-Critic (DRA-SAC) model, it optimizes task offloading and edge caching to meet URLLC constraints. This approach enables real-time decision-making while balancing delay and energy trade-offs. However, it assumes static device distributions and simplified channel conditions, limiting scalability in dense, real-world IoT scenarios [1].

AI-driven approaches have been applied to enhance 6G satellite-terrestrial integration through dynamic spectrum sharing and predictive maintenance. These methods improve latency and reliability using techniques like Lagrangian dual decomposition. However, simplified traffic models and the lack of real-world handover testing limit their scalability in complex, high-density networks [2].

Another study introduced transfer learning into DRL for resource management across RAN-edge slices. This method accelerates convergence and balances QoS using priority-based scheduling. While effective in simulations, it depends heavily on hyperparameters and assumes stable traffic, with limited validation in real-world Open RAN environments [3].

Methodology for this work using AI-Based Handover Mechanisms is presented in Fig-1 and each step is presented below:

1. **Hybrid 6G Network Simulation:**
   A hybrid 6G network environment is simulated, comprising both terrestrial Base Stations (BS) and Low Earth Orbit (LEO) satellites to create a comprehensive communication infrastructure.
2. **Real-time Data Collection:**
   Key performance metrics, including signal strength, latency, speed, network load, and link quality, are continuously gathered from the simulated network environment.
3. **AI Model Training:**
   A Deep Q-Network (DQN) combined with Long Short-Term Memory (LSTM) is trained using the real-time input metrics to learn and predict network conditions effectively.
4. **Optimal Node Selection:**
   The trained DQN/LSTM model makes an intelligent decision to select the best communication node for the user, choosing between a LEO satellite or a terrestrial Base Station based on the analyzed metrics.
5. **Seamless Handover Execution:**
   A soft handover is initiated with a pre-authentication mechanism to smoothly transfer the user's connection to the newly selected optimal node without interrupting the service.
6. **Performance Evaluation:**
   The effectiveness of the system is evaluated by measuring the final output metrics, which include handover delay, packet loss, overall throughput, and the decision-making accuracy of the AI model.

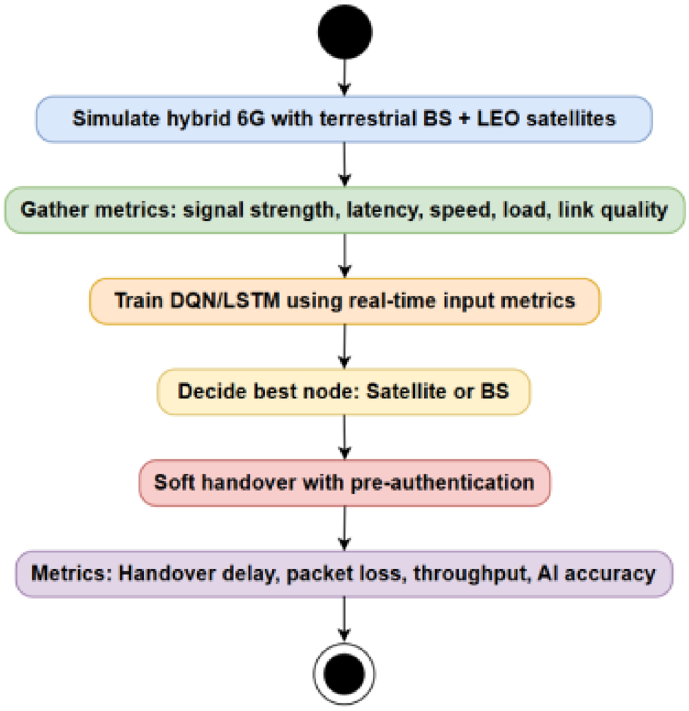

Fig. 1: Proposed Methodology for AI-Based Handover and Resource Optimization

This work presents a critical step towards realizing intelligent and autonomous 6G networks, ensuring robust connectivity in hybrid satellite-terrestrial environments. Future work will focus on deploying this framework on a physical testbed, incorporating advanced security protocols for handovers, and exploring energy-efficiency optimizations for the AI model.

***Index Terms*—6G, Vertical Handover, Hybrid Satellite-Terrestrial Networks, Deep Reinforcement Learning (DRL), Deep Q-Network (DQN), Mobility Management, Low Earth Orbit (LEO), Quality of Service (QoS).**

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