

ABSTRACT

Data centers are a critical infrastructure for modern computing systems. Maintaining optimal temperature levels in data centers is essential for ensuring system reliability and performance. Wireless Sensor Networks (WSNs) have emerged as a reliable solution for real-time temperature monitoring. However, the energy constraints of the WSN nodes pose significant challenges in extending the useful life of the network.

This study proposes an energy-efficient node scheduling mechanism for temperature monitoring in data centers using WSNs. This approach utilizes an adaptive sleep/wake-up scheduling scheme integrated with reinforcement learning, which allows sensor nodes to dynamically manage their operational states (sleep, wake, transmit, or receive) based on current network conditions. The goal is to reduce energy consumption while maintaining reliable data transmission.

Simulation results using NS2 show that the proposed Adaptive Node Activity Scheduling (ANAS) method provides significant performance improvements compared to conventional methods. ANAS successfully reduces energy consumption to 757.59 Joules, lower than the manual sleep/wake-up method (2,526.41 Joules) and AODV (6,303.03 Joules). In addition, ANAS achieves a packet delivery ratio (PDR) of 95.14%, a final delay of 40.41 ms, and extends the network lifetime to 1,363 minutes, compared to the AODV method (401 minutes) and manual sleep/wake-up (805 minutes). These results prove that reinforcement learning-based adaptive scheduling is effective in improving energy efficiency, data reliability, and network lifetime in WSN-based data center monitoring systems.

Keywords: Node scheduling, Energy efficiency, Wireless Sensor Networks, Data center monitoring, Sleep scheduling, Reinforcement learning, NS2 simulation.