Scalability Challenges and Solutions in IOT Deployments

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Abstract: *The Internet of Things (IoT) continues to expand rapidly, with billions of devices connecting across industries—from smart homes to industrial automation. However, as deployments scale, maintaining robust system performance, data integrity, and low-latency communication becomes increasingly challenging. This paper investigates core scalability issues, including bandwidth congestion, centralized bottlenecks, device heterogeneity, and data processing overload. We propose a hybrid architecture combining edge computing, distributed consensus, and hierarchical clustering, validated through simulation and small-scale real-world prototype deployments. Results reveal that our architecture maintains under 200 ms latency, improves throughput by 65%, and reduces cloud upstream data load by 75% compared to monolithic cloud systems. Statistical analysis confirms these improvements (t-tests, correlation analysis). The study offers actionable design guidelines for scalable, efficient, and resilient IoT networks, especially relevant to urban smart cities, industrial IoT, and large-scale environmental monitoring.*

Keywords: IoT Scalability, Edge Clustering, Distributed IoT Architecture, Hierarchical Device Management, Real-Time Processing