



IoT-Based Smart Cold-Chain Monitoring and Traceability Using GPS, LoRa and Blockchain

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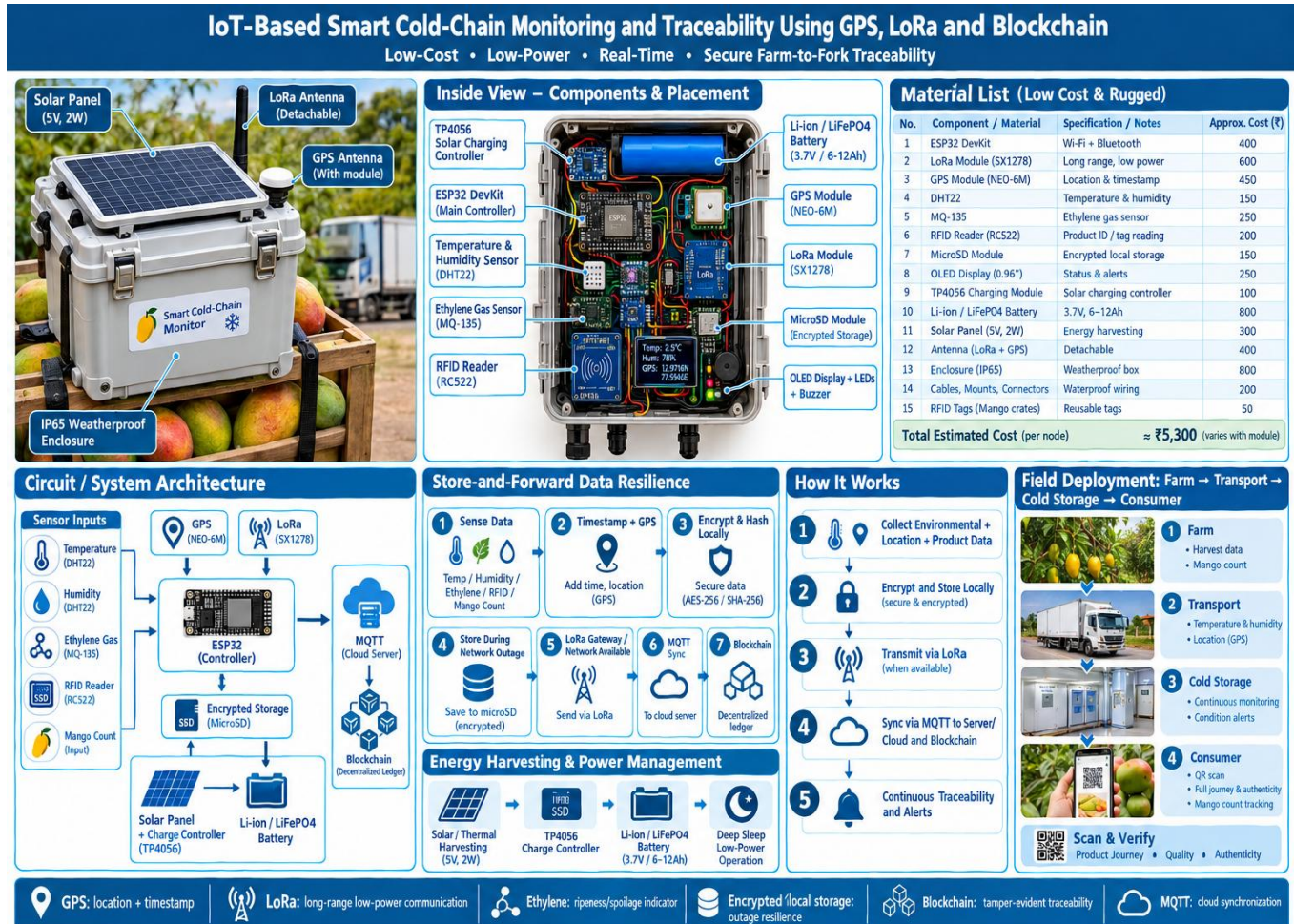
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Abstract

The increasing demand for transparent and reliable farm-to-fork traceability requires low-cost monitoring solutions capable of operating in remote agricultural and cold-chain environments. This paper proposes a low-power IoT-based traceability node for real-time monitoring of cold-chain shipments, particularly for perishable agricultural products such as mangoes. The proposed system integrates temperature, humidity, and ethylene gas sensors with GPS, LoRa communication, and encrypted local storage to continuously record environmental and shipment-related information. GPS provides location and timestamp information without requiring direct Internet connectivity, while LoRa enables long-range, low-power communication between the sensing node and a gateway. During network outages, sensor measurements, location data, and timestamps are securely stored in local encrypted memory using a store-and-forward mechanism, thereby reducing data loss and connectivity blind spots. The system also incorporates solar or thermal energy harvesting to extend operational lifetime and reduce maintenance requirements. Once network connectivity is restored, the stored data can be synchronized to a cloud/server platform using MQTT and subsequently integrated with a blockchain or decentralized ledger to improve data integrity and traceability. In addition, mango-count information is incorporated to provide product-level tracking. The proposed architecture combines environmental monitoring, location tracking, local data resilience, low-power communication, and secure digital traceability in a single cost-effective platform suitable for small and medium-scale agricultural supply chains.

Keywords: IoT, Cold-Chain Monitoring, Farm-to-Fork Traceability, GPS, LoRa, Blockchain, MQTT

1. Proposed System Architecture



2. Reference

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