ABSTRACT

Supply Chain Management involves the coordination and management of various interconnected activities and processes across different organizations and functions within a supply chain. Real-time monitoring, efficient data handling and secure business transactions are vital for effective operations of supply chain management. As regards, temperature-controlled supply chain system or 'cold chain network' there arise certain core challenges. Extraneous factors could impact the operating environment. Security risk in cold chain network can affect the supply chain's integrity and auditability. Our proposed layered architecture – "SiC-Chain" provides real-time data collection, seamless storage, and secure communications for cold-chain applications. SiC-Chain architecture has been designed with three types of operations namely SiC-Chain Enrollment, SiC-Chain transactions and SiC-Chain Secure IoT.For implementation of SiC-Chain, the fishing industry has been identified as an application. For real time monitoring, a smart IoT device named 'SiC-SBox' has been developed. A user-friendly web-based application that can be used on mobile devices has been created to provide access to the SiC-Chain system. A SiC-Chain prototype development environment consist of SiC-SBox, SiC-Chain Backend on the Cloud and SiC Chain Application with a smart Dashboard has been developed and evaluated.

To address the concern of secure transactions within the supply chain management entities, SiC-Chain architecture employs a novel dynamic key dependent cryptographic algorithm. This algorithm selects non-linear S-Boxes dynamically based on the round key generated for each round. By using cryptographic techniques, the architecture provides a secure communication channel for transmitting the sensor data to web application. Experimental results and evaluation show that encryption of IoT data using the algorithm can contribute to the security of cold chain applications and ensure the confidentiality of transmitted data. The performance analysis has been done on encryption time, decryption time, strict avalanche effect, throughput, and memory consumption. The novel nonlinear S-Boxes used in SiC-Chain architecture was screened for non-linearity, Differential and Linear approximation probability analysis which showed excellent outcomes compared to other lightweight algorithms.