Supply Chain Damage Tracking on the Blockchain DApp Summary

Overview

This DApp has contracts which track product damages on the blockchain. The scope in the DApp starts with products leaving a Supplier's warehouse via a Carrier, possibly routed to a fulfillment center, and then being delivered to the end customer. Five parties are involved: Suppliers, carriers, fulfillment centers, pool points, and customers. Each party will log transactions to the blockchain. The Supplier will log the products are picked up by a carrier and can self-report damage. The carriers / delivery agents will log when they have picked up products from the Suppliers, fulfillment centers, and pool points. The Carriers / Delivery Agents will also log when they have dropped off items at fulfillment centers, pool points, and at customer addresses. The fulfillment centers and pool points will log when they have taken receipt of the products and when products are picked up by carriers / delivery agents. The customers can still report if there is damage to any products to the E-Commerce company and the E-Commerce company does not have the ability to alter the blockchain with damage to any transaction, but can opt to reimburse the customer out of their pockets at their discretion. X-ray IoT sensors audited by a 3rd party will scan the products as they are picked up and dropped off between parties.

End-to-end Supply Chain

The Supplier

The Supplier imports the products from the manufacturer or makes the products themselves. Each product has a unique Supplier part number unique to the Supplier. A Supplier may do their own QA beforehand but it's not required. If a Supplier does do their own QA, then they can report early damage transactions to the blockchain and the Supplier will not be penalized. Once a customer places an order on an E-Commerce site or if the Supplier is shipping products to an E-Commerce fulfillment center, a request for pickup is sent to a carrier and a carrier comes to pick up one or more products. Once a carrier arrives at the Supplier's address, the x-ray IoT sensors at the loading docks scan the products to check for damage. Each transaction is recorded to the blockchain by the Supplier if it has damage or not and whether it's been picked up by the carrier. Those products with damage are not loaded onto the truck and the Supplier is penalized for trying to send a damaged product.

The Carrier

When the carrier gets to the Supplier's warehouse, those products which make it past the loading dock x-ray IoT sensors are put onto the trucks. If a product is being shipped directly to a customer from a Supplier's warehouse, the carrier's IoT sensors will scan the products as they leave the truck and record the transaction to the blockchain with isDamaged = 0 for no damage or isDamaged = 1 if there is damaged. Products with damage are not delivered to the customer

and the Supplier and E-Commerce company are notified. If the products are not damaged coming out of the Supplier to the customer, then the product is marked as delivered with no damage to the blockchain and the Supplier, E-Commerce company, and customer are notified of the successful delivery. If a product is being shipped to a fulfillment center or pool point, then when a carrier gets to the FC or PP, the products are scanned by the loading docks. Each transaction is logged to the blockchain. Those with damage are the fault of the carrier.

The Fulfillment Centers

The fulfillment centers (FCs) are strategically located to customers to support fast shipping and hold the products until a customer purchases an item. Suppliers pay money to house their products in FCs. When a customer places an order through the E-Commerce company, the FCs make a request-for-pickup for the carriers. All products leaving an FC onto a carrier go through IoT x-ray scanners at the loading docks and all transactions are recorded to the blockchain. Those products damaged are the fault of the FC. Product undamaged are loaded onto the carriers. Products can then be shipped to a pool point or to the end customer.

The Pool Points

Pool points are smaller warehouses located close to customers. Products get pooled here depending on the end location they are going to. When products arrive here, the IoT scanners at the loading docks scan the products before they are re-routed and all transactions are recorded to the blockchain. The products entering with damage are the fault of the carrier who dropped them off. Non-damaged products enter the warehouse.

The Delivery Agents

Delivery agents are synonymous with carriers, but there are a lot of smaller 3rd party carriers who can deliver items from pool points. When a delivery agent picks up items from FCs or pool points, the IoT scanners in the FC or pool point loading docks scan the items. Every transaction is logged to the blockchain. Products with damage are the fault of the FC or pool point. Non-damaged products are transported by the delivery agents. Once a delivery agent reaches an end customer's address, the IoT scanners x-ray the products as they leave the vehicle and these transactions are recorded to the blockchain. If a product is damaged, the delivery agent is at fault and the Supplier and E-Commerce company are notfied. If a product is not damaged, the product is marked as delivered and the Supplier, E-Commerce company, and customer are notified.

The Customers

Customers purchase the products from an E-Commerce company. A customer cannot record a transaction to a blockchain, but a customer can report any damage to the E-Commerce company to refute the transaction which states the product was delivered with no damage.

The E-Commerce Company

The E-Commerce company displays the products on their website and does not own any of the products. The E-Commerce company owns the fulfillment centers. If a customer reports damage, then the E-Commerce company cannot override the transaction in the blockchain associated with the delivery. The E-Commerce company can only give the customer money out of their own wallet and not charge the Suppliers, carriers, or delivery agents.

The Contracts

IoT Sensors and Oracles

The sensors scan the products for any damage. Any time there is damage with a product, the event is sent to an oracle. The oracle then emits the event. A listener will receive the events emitted by the oracle. When a “IsDamaged = 1” or “IsDamaged = 0” is received, the timestamp is recorded.

The oracle contract is named DamageOracle and contains an IsDamaged function to emit an event.

Transactions

The main contract is named SupplyDamageChain. Products are grouped into Supplier Part Numbers and each Supplier Part Number is registered by the Supplier with register_SupplierPartNumber. The carriers, fulfillment centers, pool points, and delivery agents take receipt of the products using take_receipt. The take_receipt function updates the SupplierPartNumber struct within the contract based on the SupplierPartNumber_id that register_SupplierPartNumber returned. The specific state altered in the SupplierPartNumber struct depends on who calls take_receipt. If it’s called from a Supplier’s account, then the SupplierPartNumber struct’s supplier flag is set to true. If it’s called from a carrier’s account, then carrier is set to true. If it’s called from a fulfillment center, then fulfillment_center is set to true. If it’s called from a pool point, then pool_point is set to true. If it’s called from a delivery agent, then delivery_agent is set to true. Sensors report damage to a Supplier Part Number using isDamaged.