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Enhance Trust in Cold Supply Chain with IoT and Blockchain

Abstract

Business entities in a supply chain network engaged with cold chain packaged products maintain their individual system of records. This hinders creation of a trusted, single view of records, which is critical in case of a breach of contract. Current business processes are being disrupted by new, trusted peer-to-peer business networks that maintain a tamper-proof distributed ledger for transactions, thereby tracking adherence to service levels from the point of pick up through to final delivery. Such innovative networks include Internet of Things (IoT), fleet management integrated with supply chain and blockchain for real-time visibility by transferring the summary of health check to a distributed ledger, where all participants can view it — ensuring trust, accountability, and transparency.

Blockchain Unlocks Transparency in Supply Chain

Blockchain is among the most talked about technologies currently. From bitcoins to inter-bank financial transactions and supply chain, new blockchain use cases are being developed on a regular basis. Blockchain is basically a network of computers, where all members maintain a shared, trusted, public ledger that everyone can inspect, but no single user can control. The ledger is built using a linked list, or chain, of blocks, where each block contains a number of transactions that was performed in a given timespan.

Blockchain technology has attracted a lot of industry attention over the past few years. Finance has probably been the sector that has given it the most attention. But of late, it has been proposed as a solution in other areas as well, ranging from insurance to healthcare to supply chain.

A supply chain can be a complex and dynamic network of organizations, people, technology, activities, information, and resources involved in sourcing raw materials through to delivering finished products. In this process of supply chain, where multiple parties such as manufacturers, logistics, wholesalers, distributors, and retailers are involved, the respective parties track the movement of a product through the supply chain individually, which fails to provide a single trusted view of records.

Hence, there is a need to bring out a single view of records, which can be undisputedly accepted in case of breach of terms and agreement defined in the contracts.

Disrupting the Cold Chain

These supply chain challenges are accentuated in the case of cold chain for packaged products—in industries such as pharmaceuticals, food and beverages, and chemicals—as timely delivery becomes critical. Currently, many different parties are involved in the cold chain. Shipments pass through many hands. Product monitoring is conducted in silos, giving rise to multiple system of records, which eventually lead to distrust of the legal contracts. Often, acceptance of the cold chain packaged products per contractual terms are disputed with a loss of time, money and breach of partnership.

The shipment stage where the product is delivered to its final destination is often known, in logistics, as the "last mile." When arranging final delivery of cold chain products, many considerations need to be accounted for to maintain the integrity of the shipment.

For example, the delivery timing is important to ensure that critical labor and temperature-controlled warehouse space is available. Then, as many cold chain deliveries occur in downtown urban areas, parking availability can have detrimental impacts on the shipment. Also important is the final transfer of the shipment into cold storage facilities to avoid any breach of integrity.

Gaps in the Conventional Chain

The movement of a cold chain packaged products through the supply chain is tracked individually by the respective parties.
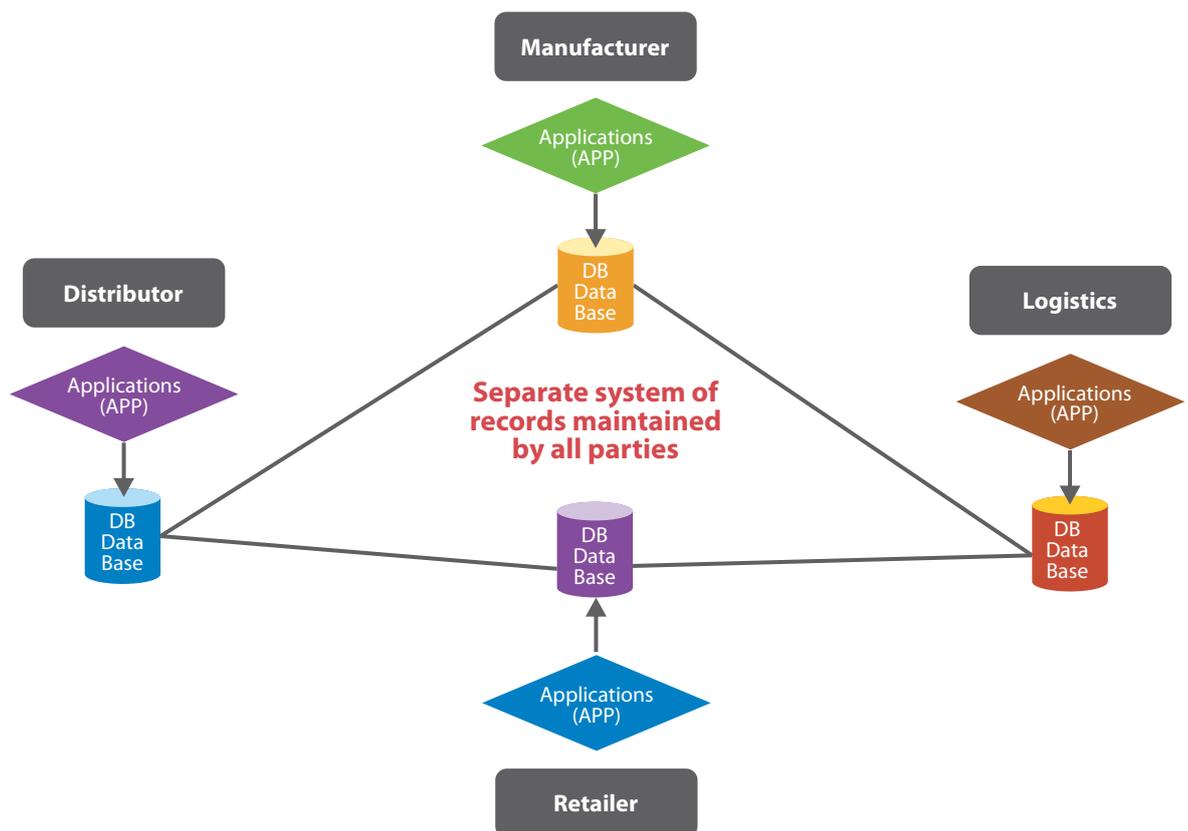

Figure 1. Cold chain packaged products tracked individually

Each party will have its own database and an application for capturing transactions and the movement of the product through the chain. This poses several key challenges:

■ **Multiple sources of truth:** At any point in time, not all of the databases may have the same data, as it depends on the organizational process involved in updating the database or any delays in propagating the data across all parties.

- **Opportunity for deceit:** This provides the possibility for parties to modify their database for business benefits and claim that their data is true.

- **Translational error:** The data in one or more of the databases may not sync up due to human error or application issues. This would lead to a dispute between parties, resulting in increased cycle time for resolving the conflict and, possibly, delivering the product.

- **Lack of customer trust:** The customer may find it extremely difficult to identify whether the product is genuine.

How IoT-fleet Management and Blockchain can Transform Cold Chains

IoT-based fleet management integrated with supply chain and blockchain enables real-time visibility into shipment conditions, transferring the summary of conditions to a distributed ledger that all participants can seamlessly view.

Because cold chains require a higher level of end-to-end control to maintain product integrity, they tend to have higher levels of integration among its members. IoT-based processing captures data from connected devices (sensors, RFID tags, and so forth) levelled with the products, providing real-time information about the transported items — including temperature, location, speed of transport and storage conditions—to help ensure the integrity of cold chain packaged products.

Such information gathered continuously through IoT devices is summarized at regular intervals and sent as a distributed ledger over the blockchain to all the parties. Blockchain is based on the distributed ledger technology, a shared ledger across the network, which helps transactions to have public witnesses and, hence, minimal cybercrime and fraud. With the deployment of IoT and blockchain, all parties will collectively track the movement of the cold chain packaged product through the supply chain. At the end of the journey, the customer is able to learn about the products' health from dispatch to delivery, including the history of temperatures at which they were held, the full chain of custody, storage conditions and much more.

Blockchain allows for peer-to-peer communication, which means there would be no need for any massive infrastructure. Moreover, in case one of the nodes crashes, it would not bring the entire structure down.

While each party can have its own application, there will be a single data store, or the distributed ledger. Trust is ensured through several key features:

- IoT collects the parameters of the cold chain packaged products, including temperature, location, and storage conditions.

- Blockchain circulates a distributed ledger using cryptographic techniques.

- Single data store for all parties in the blockchain network to view.

- Consensus that all parties must give before a new transaction is added to the shared ledger in the blockchain.

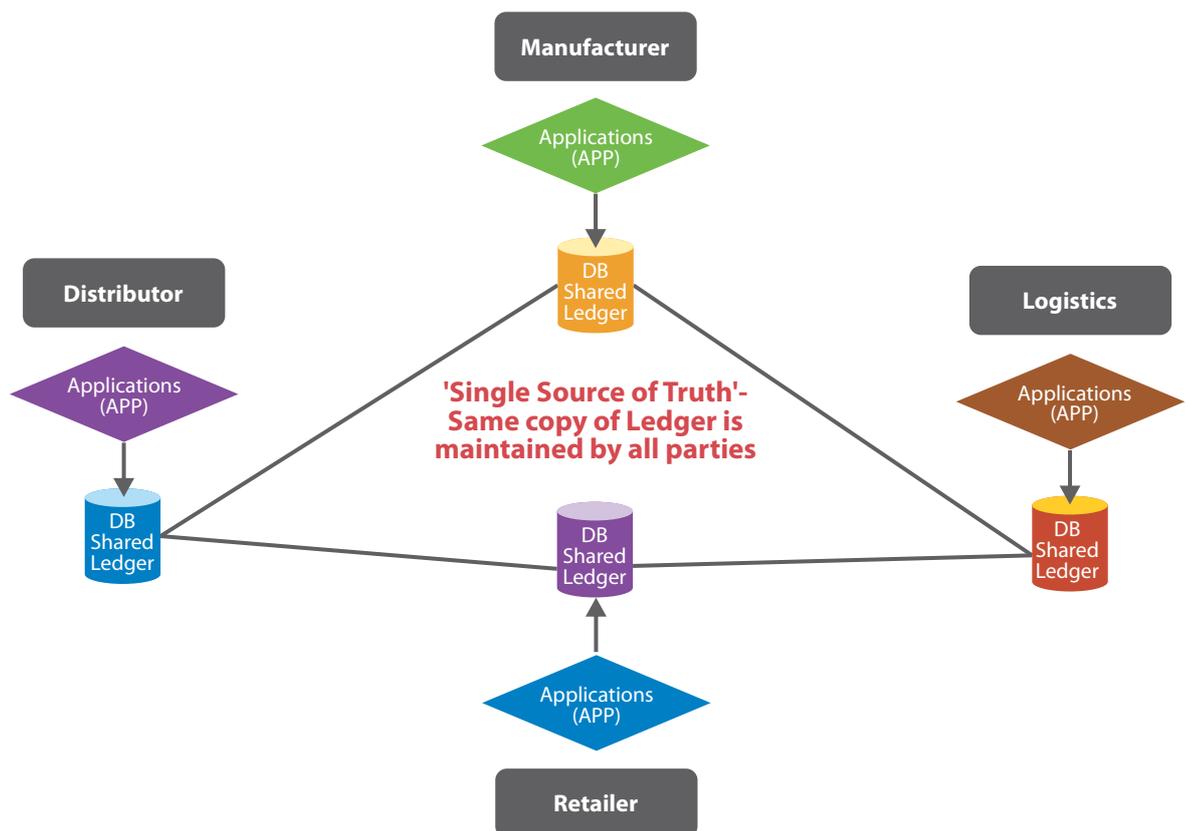- Immutable transactions recorded on the ledger that cannot be altered.

Figure 2. Cold chain packaged products tracked via blockchain

Advantage IoT and Blockchain

The benefits of the ledger-based approach of blockchain include:

- **Single source of truth:** At any point in time, all the parties can refer to the same data with a single shared ledger.

- **Security:** Fraud by any of the parties can be immediately identified by comparing the ledger copies of the other parties.

- **Early detection of translational error:** Since all parties need to give consensus, any human or application errors will be caught early in the chain.

- **Customer-centric supply chain:** The manufacturer is able to provide better customer experience as blockchain provides the opportunity to connect the manufacturer directly with the customer.

Conclusion

While the role of blockchain in ensuring integrity of data in a supply chain has already been established, the process can be further strengthened by using IoT and sensors, particularly in cold chains where the time factor becomes critical. With its promise of providing secure and transparent transactions, blockchain is the new synonym for digital trust.

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