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On-chain vs. off-chain storage for supply- and blockchain integration

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Abstract: Supply chains are the basis of most everyday life products. Both data integrity and authenticity of related information have severe implications for quality and safety of end-products. Hence, tamper-proof storage is necessary that prevents unauthorized modifications. We examine peer-reviewed blockchain technologies according to four criteria relevant to supply chains: On-chain storage, off-chain storage, verification cost and secure data sharing. Our evaluation yields an overview of concepts for modeling supply chain processes and points out that on-chain storage is currently not practical.

Keywords: decentralized storage system, blockchain, supply chain

ACM CCS: Information systems → Information storage systems

1 Introduction

Everything from the clothes on our backs to the food we eat is the end result of a supply chain. Even something as simple as a toothbrush requires the coordination of materials, intermediate processes, and distribution before it can be purchased by the consumer in the grocery store. More complex products such as computers or medications rely on similar, if not more complex, supply chains. Figure 1 shows a high level example of a supply chain. The physical product is modified or transported at each step and eventually the chain terminates. The information pertaining to the chain, however, is bi-directional and exists more statically. It is this information that needs to be verified and stored immutably.

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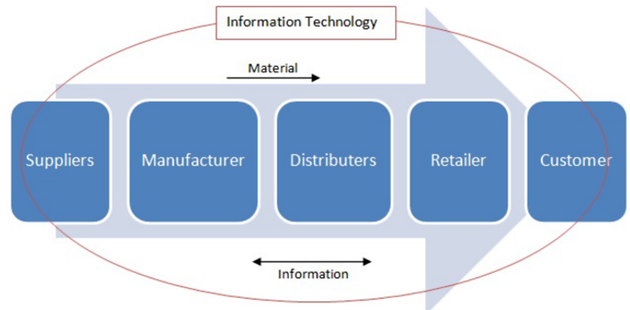

Figure 1: A high level supply chain from a retail environment showing the relationship between the physical product and the information for each link in the chain. Each link can be further abstracted into its own supply chain [20].

When considering a long and complex supply chain, how can we be sure of what was performed during each intermediate step? First approaches are already introduced for tracing products in supply chain cycles, such as [13, 15, 23, 14, 28] Further, if a problem is identified with the final product, how can we effectively determine which link in the chain produced the problem? Finally, once we have answers to these questions, how can we be sure that the information is correct? To answer this question, the following criteria need to be fulfilled: All parties in the chain can trust the information, there is no opportunity to make unauthorized modifications, and the information is available to all authorized parties. This essentially describes a blockchain.

There are several problems, however, with using a blockchain to maintain the integrity of and store supply chain information. First, a blockchain technology may have a limit to the amount of data that can be stored in a single block. Second, the cost of committing a transaction to a block may be prohibitively expensive. Third, it may be necessary to share information for computation or verification, but the data itself is confidential or should not be readable by all parties in the chain.

The remainder of this paper examines a selection of available technologies in order to gain an overview of which features are currently available, and discuss how these features can be applied to supply chains to answer the open questions from above. Section 2 outlines how the

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