SUPPLY CHAIN WITH BLOCKCHAIN SHOWCASE RFID

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Introduction

Fraud in the fashion industry is a major challenge for brand manufacturers. Counterfeit products are often produced in Asian countries and are marketed through established distribution channels. Often, the same processes are used to produce, transport, and distribute the originals. For a consumer, it is not possible or very difficult to distinguish and original from a counterfeit. The differences are marginal to nonexistent. Clothing and accessories including t-shirts, pants, jackets, shirts, sweaters, shoes, suits, bags, and glasses are all at risk for being counterfeited. Tamper-proof Blockchain technology in combination with RFID offers an optimal solution for identifying original products.

The basic idea is to label each product with a one-to-one counterfeit-proof feature and to then track it using a global supply chain based on a Blockchain. This paper describes the solution based on the Blockchain-RFID combination.

What is RFID?

Radio Frequency Identification is an automatic identification method that implements contactless communication between a chip and a reader.

An RFID chip can transmit information stored with radio waves to a reader (RFID scanner). For example, the ID card in credit card format contains an RFID chip, which enables a contactless reading of personal data via a scanner. An RFID chip comes without its own power supply. The scanner emits a wave on a radio frequency. The RFID chip captures energy from these waves and stores it in a capacitor. The microcontroller is then supplied with power for the time of the interaction. Most RFID chips operate in the frequency range 865 to 869 MHz and use the principle of “modulated backscattering.” At the same time secondary frequencies, which are interpreted as digital data by the RFID scanner, are backscattered /2/.

RFID technology is mature and is already used in many areas such as:

- Vehicle identification
- Electronic construction documentation
- Banknotes
- Payment cards
- Identification of people
- Identification of animals
- Authentication of medicines
- Tube stations and filling plants
- Printed circuit boards with RFID tags
Blockchain solution

What is Blockchain?

Blockchain is an invariable, highly available and distributed data case in which all data written into it is tamper-proof and can be protected against unwanted access via encryption. It is like a database in which, similar to in a normal ledger, all transactions are entered chronologically. In order to prevent manipulation, blocks are formed and then closed with a checksum. The blocks are then arranged one after the other, each block containing the checksum of the previous block. Thus, a type of chain is created, hence “Blockchain.” Many copies of this chain are created and distributed. There is therefore no central unit that has control over the chain.

The Blockchain ensures that all participants have the same copy of the Blockchain, making it easy to detect and subsequently exclude altered versions.
Functional principle of a Blockchain

**Transaction**: the primary fundamental element of the Blockchain. Two parties exchange information with one another. This can be the transfer of money or assets, the closing of a contract, or a medical record or certificate that will be saved digitally. Transactions function in principle like the sending of e-mails.

**Verification**: checks if a party has the according rights for the transaction. The test happens instantaneously or it is written in to a queue, and will be tested later. At this point nodes (computers or servers in the network) will become included and the transaction will be verified.

**Structure**: the transactions will be grouped in to blocks, which are encrypted using a hash function as a 256-bit number. The blocks can be distinctly indentified by the assignment of hashvalues. A block includes a header, a reference to the preceding block, and a group of transactions. The sequence of the linked hashes produces a secure and independent chain.

**Validation**: before the blocks are produced, the information must be validated. The most widely spread method of validation of open-source Blockchain is the “proof of work” principle. This procedure can be illustrated by the solving of a difficult mathematical problem through the user or the computer.
Blockchain mining: the term mining refers to "digging." In this process the block will be produced and hashed. To come to the train, the miner must solve a mathematical riddle. The first person to find the solution will be accepted as the miner. The miner receives a reward for his work.

The chain: after the blocks are validated and the miner has carried out his work, copies of the blocks will be distributed in the network and to the nodes. Every node adds a block to the chain in a steady and unchangeable manner.

Defense: when a dishonest miner tries to change a block in the chain, the hash value of the block and the following blocks will be changed. The other nodes will recognize this manipulation and the block will be eliminated from the main chain.
The use of Blockchain in the textile industry

The combination of Blockchain and RFID offers advantages in the following areas:

- Identification of counterfeits
- Production
- Inventory control
- Warehousing
- Distribution
- Logistics
- Automatic object tracking
- Testing of the supply chain

The identification of an original can be carried out at any time and at any location with the help of an integrated RFID chip. If the product contains no RFID chip or a non-RFID chip registered in the Blockchain, it is treated as a counterfeit. The Blockchain makes it possible to carry out plausibility checks. For example, you can check whether the company actually has a plant in a specific location, for example, if the product could plausibly be at the specified location (when, for example, each transport step has been saved). The appearance of the same product at the same time on opposite ends of the earth would be an indication of a counterfeit. For retailers and buyers, the history of a good tracked in the supply chain is equivalent to a certificate. For retail customers, this means a further increase in value.

Supply chain with example

At this point, the production and supply chain is described by way of example on textiles. First the RFID chip is registered in the supply chain. Subsequently, it is handed over to the manufacturer of a garment and integrated during the manufacturing of the product. After production, the goods are packaged and fed into the logistics chain. The products are transported to the port, for example, and shipped by a shipping company. From the destination port, the goods are delivered to the wholesaler. The wholesaler distributes the textiles to retailers, who sell the clothing to the end consumer. All of these steps are recorded via the RFID chip and are stored in the Blockchain.
A precise example of such a file in a Blockchain might look like this:

```
// Simple Logfile structure
// PRODUCT_ID/[SCAN_TIME]/COUNTRY/COMPANY_ID/

36478951449825/[07/Mar/2017:06:05]/KH-12/24894257
36478951449825/[08/Mar/2017:08:03]/KH-12/24894257
36478951449825/[08/Mar/2017:12:45]/KH-9/57126697
36478951449825/[22/Mar/2017:07:08]/DE-HH/57232655
36478951449825/[25/Mar/2017:10:04]/DE-BE/26464345
36478951449825/[26/Mar/2017:18:44]/DE-SN/26448582
```

With this log file, the supply chain is fully traceable. The product has a unique ID. In addition, the product is scanned at every production stage or site change, and the data is stored in the Blockchain. This results in a fully traceable product history. In our example, the product was made in Phnom Penh, Cambodia and deposited with the unique country ISO (KH-12) in the Blockchain. It then arrived in the province of Koh Kong (KH-9), at which point it was shipped to Hamburg and then ultimately traveled through Berlin (DE-BE) to arrive in Saxony (DE-SN).

A more comprehensive data collection is also possible. It is also possible to add further information, such as status models, free text, transport conditions, and photos as required, for example, for the geoPosition of the data record generation. In this case, the data is stored in JSON format.
An example of a more comprehensive history might look like this:

```json
// JSON Logfile structure
{
  "id": "Product-123",
  "deviceId": "ScannerId",
  "entries": [
    {
      "type": "temperature",
      "content": 22
    },
    {
      "type": "position",
      "content": {
        "lat": -13.123,
        "lon": 42.456
      }
    },
    {
      "type": "state",
      "content": "shipped"
    },
    {
      "type": "image/png",
      "content": "image data as base64 encoded string"
    }
  ],
  "timestamp": 1490363343189
}
,...
```

In addition to the supply chain, further data could be written into the Blockchain. These include the origin of the raw materials (fabric, twine), any changes in state that occur including transfers of ownership, various environmental conditions (temperature, humidity) and the working conditions and compensation of factory employees. This is especially important for fair trade products. If suppliers were to refer to their documents, approvals, and certifications, an audit would be easier for contracting companies than before.
Example of a manufacturing and distribution process

Here an entire manufacturing and delivery process with the respective intermediate steps is described. The process assumes that a product is sold to an end consumer via a shop after production and transportation.

Registration of the RFID chip

Precondition: Manufacturer receives registered chips.

Description: In the production process, the manufacturer inserts the RFID chip into the product.

Postcondition: The RFID chip is included in the product, making the product clearly identifiable.

Manufacturer

Precondition: Manufacturer received registered chips.

Description: In the production process, the manufacturer inserts the RFID chip into the product.

Postcondition: The RFID chip is included in the product, and the respective product is thus clearly identifiable.
Transporter

**Precondition:** RFID chip is included in the product, and the respective product is thus clearly identifiable.

**Description:** The finished products are transported and handed over to the intermediary by a logistics company. The resulting data (for example location changes, transitions, temperature, humidity, vibrations, etc.) are linked with the product ID and stored in the Blockchain.

**Postcondition:** In the Blockchain the product can be identified via the one-to-one RFID chip and contains all recorded data from the transport process.

Middleman

**Precondition:** In Blockchain, the product is identifiable via the one-to-one RFID chip and contains all recorded data of the transport process.

**Description:** The finished product is delivered to the final consumer via the intermediary. Any changes in the state (location, transitions, temperature, humidity, vibrations, etc.) are stored in the Blockchain.

**Postcondition:** In the Blockchain the product can be identified by the one-to-one RFID chip and contains all the data collected in the middleman process.
**Consumer**

**Precondition:** In Blockchain, the product is identifiable via the one-to-one RFID chip and contains all the data collected in the middleman process.

**Description:** The intermediary gets the products to the consumer

**Postcondition:** The consumer is clearly identified by the RFID chip. It can inspect and verify all relevant manufacturing and transport data.

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**Supply Blockchain**

**Precondition:** The supply Blockchain is available for all process participants.

**Description:** In the supply Blockchain, all the data that is generated for an identifiable product is stored.

**Postcondition:** All data within the production and distribution process are stored in the supply Blockchain.

**Advantages of the supply Blockchain system based on RFID**

As soon as a branded item does not have an RFID chip, it is not considered original. Furthermore, no more textiles can be produced than there are chips. This ensures a product scarcity, ensuring a certain exclusivity. At the same time, consumer confidence in a brand will increase. One can assume a reduction in loss of value of a product when counterfeit products are eliminated. If the expensive brand goods are counterfeited, the counterfeit goods can be identified as such by retrieval authorities using the supply Blockchain. A circulation of counterfeit goods can otherwise become extremely complicated and is often associated with a considerable loss of value.
In the future the size of chips will be reduced so that they can no longer be seen with the naked eye. The main problem for currently supply chain detection systems is that the data is not tamper-proof and distributed. This is eliminated by the implementation of Blockchain. Each participant stores their data in their own database instead of in a central cloud, and each database is linked back to the Blockchain. As a result, the operating costs are reduced rapidly, accompanied by an increase in quality.

Note: The connection with RFID is a practical proposal, and other tamper-proof identification methods may also be suitable for different products.

**What are the advantages of the Blockchain?**

The greatest advantage of the Blockchain is that it is tamper-proof and fail-proof. As discussed in the introduction, each Block is hashed and thus encrypted. The second security aspect is the distributed nature of the Blockchain.

The distribution has a second important advantage: If the database is partially compromised, the remaining nodes can be used to keep the database running. Further advantages are the system independence, so that it can be run on the system of your choice (PC, Mac, Linux, Smartphone, Tablet, etc.) In addition, Blockchain accelerates the process as a whole by eliminating human intervention (a mid-check, for example).

Further advantages include:

- Scalability
- Safety
- Proof of correctness
- High performance applications
- Low latency of operations
- Self-organizing structures
- New commercial applications
- Cross-checks and plausibility checks
What Blockchain cannot ensure

Blockchain stores and distributes contained data. Access and distribution among the process participants is substantially simplified. If, however, goods without registered chips are circulating, the traders and consumers become suspicious of the product. If counterfeits possess a valid identification number agreeing with the status model but inconsistent with the product history (for example, the original was sold years ago or is still located in a container on a high-speed ship between Asia and Europe), it is also up to the participants to trust them. This mistrust as well as the consequences cannot be provided by the Blockchain. However, the Blockchain is the perfect system for testing this.

Prototype of a Blockchain based tracking system

Together with a logistics company, faizod is working on a Blockchain based tracking system. The underlying permissioned Blockchain is based on Hyperledger and currently consists of four nodes. The prototype currently consists of four process participants. The example below shows the four login screens.
Each participant can log in via a WebUI and see the relevant data.
There is an app for Android and iOS, which makes it fast and easy to retrieve data from mobile devices. In addition, new entries can be created via the apps.

The mobile devices can also be directly linked to an RFID scanner.
Summary and outlook

The circulation of counterfeit products inflicts damage in the billions to the clothing industry. This paper described how to limit such counterfeiting through tight monitoring and the marking of products. All original products can be equipped with an RFID chip and displayed in the global Blockchain. If a product is not registered in the database or if there is no plausible history counterfeiting can be assumed.

References

/1/ https://de.wikipedia.org/wiki/RFID#Bezahlkarten

/2/ https://www.welt.de/print/die_welt/wissen/article109536379/So-funktioniert-ein-RFID-Chip.html
faizod is a solution and service provider for Blockchain technology as well as modern enterprise software solutions. Professionalism, effectiveness, and innovation have always been the core competencies of faizod on software projects of all sizes and industries.

**Our mission:** To help companies of various sizes and sectors reach more!

**Our vision:** To keep software development at a top level!

faizod is an innovative leader for Blockchain technology. Our applications and services support customers worldwide by helping them conduct business profitably, adapt continuously, and grow sustainably.