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F&E INSIGHTS

How blockchain could affect manufacturing and R&D

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Blockchain, the technology behind virtual currencies such as Bitcoin, is being promoted by many as one of the most promising emerging technologies. Similar to the internet in its early days, blockchain (often referred to as „distributed ledger technology“) must be seen as a foundational technology, enabling a great variety of potential applications. In theory, most software applications today could somehow be realized through or complemented by blockchain. However, not every application that can be realized through blockchain should be.

The blockchain’s fundamental structure

At its core, the blockchain is a **distributed, immutable database**, able to confirm exactly when and by whom a given transaction has been made. However, its underlying technologies (peer-to-peer networks, cryptography, and game theory) have been around for years, and the blockchain is a rather new way of effectively combining the three (Figure 1).

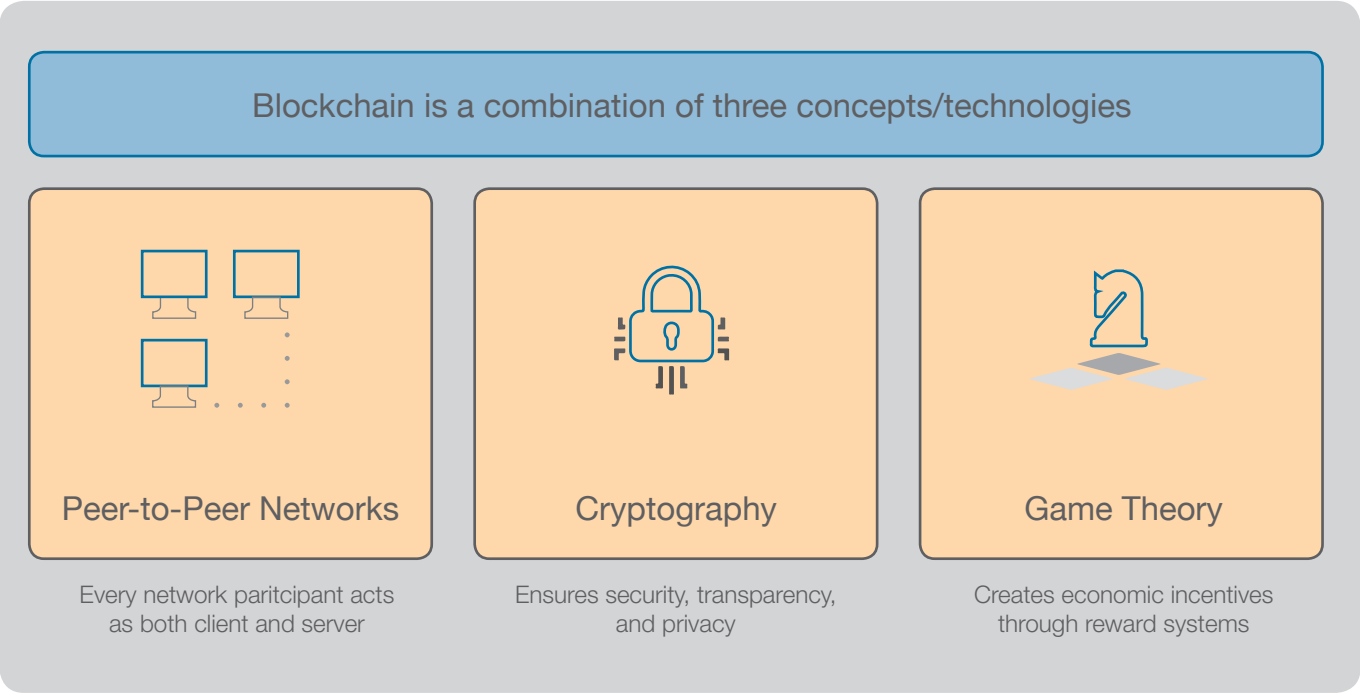

Figure 1: The blockchain‘s underlying technologies (Source: Own representation)

After a certain amount of individual transactions have been conducted within the network, these transactions (“Data 1–Data N”) are being summarized in a block and subsequently added to the blockchain. With the help of **cryptographic hash functions**, every block is linked to both its

preceding and succeeding block. This essentially results in a **chain-like connection where all blocks are securely connected to one another** (Figure 2).

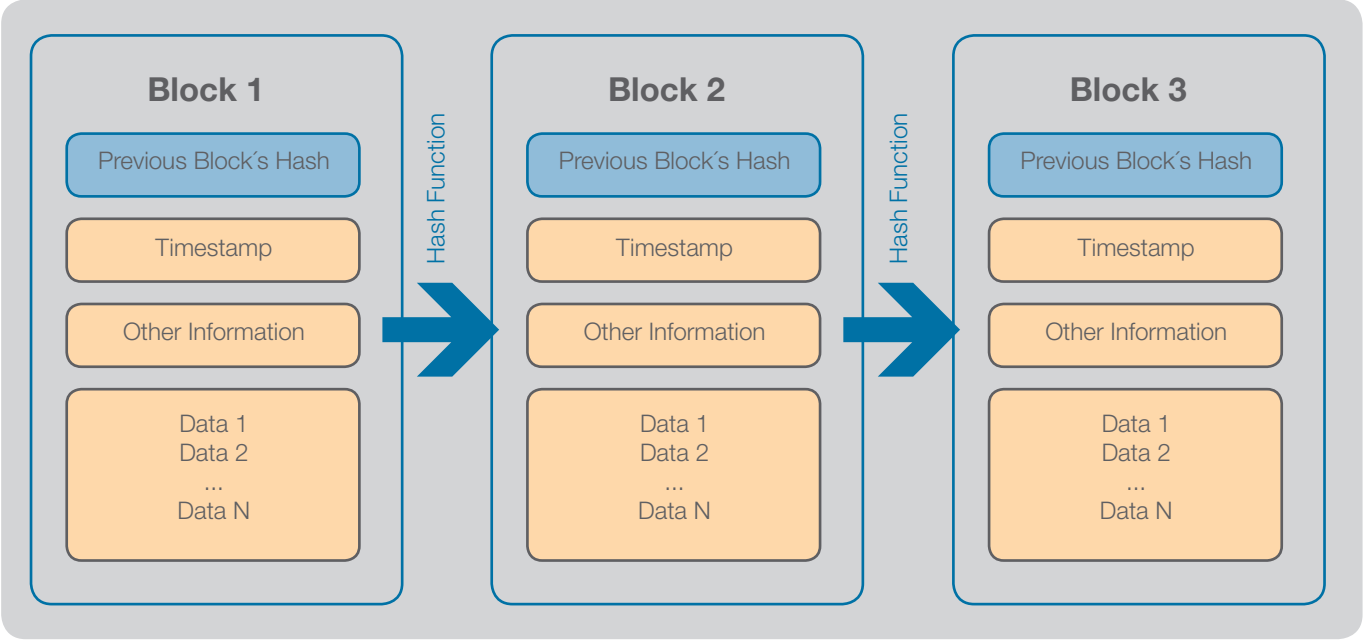

Figure 2. Basic blockchain structure (Source: Own representation)

Consensus mechanism

Whenever a new block is to be added to the chain, a majority of the network needs to first agree on the current state of the entire blockchain. This consensus mechanism makes the information stored on the blockchain **virtually tamper-proof** and creates **an irreversible record of transactions**.

However, this consensus mechanism is also what greatly **limits transaction speed and subsequently the scalability of blockchain applications**. Although transaction speeds and other limiting factors are constantly being improved, the blockchain should not be seen as the solution to all of world's problems but rather as a technology that can bring great value in very specific environments and applications.

Where blockchain could provide value

Situations that favor the use of blockchain technology include

- when *multiple parties are sharing and updating shared data,*
- there is a *need for reliable records,*
- there are *intermediaries that add costs, and/or*
- there is a *lack of trust between involved parties.*

Some of the **blockchain's key advantages** include disintermediation, improved product traceability, increased transparency of transaction histories, as well as enhanced security of records regarding fraud and unauthorized activities.

Blockchain in manufacturing

Although the manufacturing industry is certainly lagging behind the financial industry in terms of blockchain adoption, there are **three main categories** where blockchain technologies can impact manufacturing companies.

With regard to **supply chain and logistics**, manufacturing companies will benefit from increased traceability and visibility. Blockchain could, for example, help to ensure that all parties within the supply chain access the same documents and information, thus reducing the risk of communication or data errors and lowering administrative costs. Knowing exactly how parts and finished goods are being passed through the chain of subcontractors can also help to decrease losses from counterfeit products, as well as allow OEMs to pinpoint exactly where specific parts came from in case of malfunctions. This can further help companies to prove that materials were sourced in alignment with corporate social responsibility standards.

The **Internet of Things (IoT)**, a future key driver of industrial growth in itself, is also said to benefit from blockchain technologies. Security of IoT systems (or the „Industrial Internet of Things" as referred to in a manufacturing context) will be enhanced as the blockchain can enable network systems without the need of a central cloud server. This central cloud server architecture is what makes IoT systems vulnerable to hacking, as every device within the network can grant hackers access to the entire system (single point of failure). Furthermore, the blockchain can help to identify and authenticate individual IoT devices, a process that currently requires third-party certification, which again adds costs and limits network scalability. Projects such as the Trusted IoT Alliance, which amongst other companies consists of Bosch and Cisco Systems, are working on blockchain-based IoT ecosystems and have already launched test networks.

The third and last category where blockchain will transform manufacturing is **distributed manufacturing**. Distributed manufacturing, mainly in the form of 3D printing, will allow companies to increase production flexibility, shorten shipping routes, and significantly reduce the need for in-storage spare parts. Blockchain solutions will thereby help to secure intellectual property (e.g., construction files) whenever printable files are sent to contractors or other third parties. Furthermore, by equipping parts with RFID chips or other identification measures, it will be possible to trace products from the very moment they were created. Projects such as the Secure Additive Manufacturing Platform (SAMPL), a cooperation between companies such as Airbus, ProSTEP, and the Fraunhofer Institute are already trying to establish blockchain-based 3D printing platforms that will help increase security in additive manufacturing. The project's goals are to protect files from piracy, help identify originals, ensure traceability of printed parts, secure data from unauthorized access, as well as ensure the integrity of individual files.

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Blockchain in R&D

In addressing the question of how blockchain could affect R&D processes within manufacturing companies, it must be concluded that, at least at this point in time, blockchain technologies are generally better suited for other environments such as logistics, the financial sector, or the public sector. Many of those blockchain-favoring circumstances described above (multiple parties sharing and updating shared data, the need to be able to trust the records, existing intermediaries that add costs, and especially missing trust between the parties involved) only partly apply to R&D environments, often making traditional software solutions favorable. However, as explained earlier, blockchain enables a variety of applications, some of which can also bring value to R&D departments.

Blockchain-based **3D printing** solutions as described above can also be relevant within product development. The small production quantities of prototypes or early samples make 3D printing a good alternative to investment-heavy production methods, such as injection molding, especially at the early stages of product development. The previously mentioned SAMPL project and similar initiatives should therefore be monitored closely.

Similar to how the blockchain could protect files within 3D printing processes, it might eventually be possible for the technology to **help secure files within virtual simulation and test environments**. Simulations might someday be run in a virtual black-box, providing companies with the results needed without giving access to the actual construction files. However, there are currently no projects or initiatives on this topic, making it unlikely to appear anytime soon.

An application that is currently much more feasible from a technical standpoint is the **storing of hash values on a blockchain**. Amongst others, Bernstein Technologies have developed a service that allows companies to turn any file of unlimited size into a fixed numeric code (hash value), which is then stored on the blockchain. By its nature, a hash value does not reveal any information about the underlying document. However, every time an identical file is inserted into the same hash algorithm, it will result in the very same hash value. With every block on the blockchain containing a timestamp, combined with the irreversible nature of the blockchain, this concept, referred to as **defensive publishing**, lets companies effectively prove that they were in possession of a certain document at a given point in the past without having to prematurely reveal its content. A prime example where this concept could be used is in laboratory notebooks. Research institutions have a great interest in being able to prove to legal institutions or competitors that the content of their laboratory notebooks has not been altered.

Similar to the concept of defensive publishing, almost any document can be turned into a hash value and stored on the blockchain. This could prove valuable wherever there is an interest in being able to later prove that the document in question has not been altered. Product specifications and change requests are another example where R&D departments might have an interest in having **an immutable single version of truth (SVOT)** of the document stored on the blockchain.

In both cases, the blockchain essentially takes on the role of a notary. However, blockchain solutions can provide the service at a fraction of the cost and with far better automatability and scalability.

A current and rather vague potential use case is the blockchain's possible involvement in creating **digital product backbones** in the form of a product's **digital twin**. Although an idea has been published that describes a scenario wherein a majority of documents related to a given product are stored (or at least a referenced to) on the blockchain, it will most likely take years before the first prototypes are operational. Nonetheless, the idea holds great potential and should therefore be monitored over the next few years.

Conclusion

Blockchain is a technology that will affect most if not all areas of business in some way or another. However, since the blockchain's greatest potential lies in its ability to disintermediate and optimize very specific processes, companies should first evaluate exactly where and how they could benefit from it and whether blockchain-based solutions could provide an advantage compared to traditional ones. Rather than quick and disruptive, overall adoption to the technology is likely to be more gradual, starting with the most rudimentary applications and slowly gaining momentum as the technology itself, individual products, as well as the legislation surrounding it improve.

Interested? Get in touch!

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