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# Blockchain and CSCW – Shall we care?

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**Abstract.** This exploratory paper examines the relationship between CSCW and emerging blockchain technologies. Although the blockchain technology is at first sight not directly related to CSCW, this paper will identify a number of CSCW research areas that are relevant and that can either profit or contribute to blockchain research. To open CSCW research to new areas and to stipulate a discussion between the disciplines, the paper will start with a brief introduction to basic blockchain concepts followed by an exploration of the relationships between the two research areas. It concludes with an initial proposal on how CSCW research results and concepts can inform blockchain design.

## Introduction

Over the last two years, we have experienced an increasing interest into blockchain technologies. This is furthermost caused by the hype around cryptocurrencies such as Bitcoin or Ether. However, more interesting than this fascination in financial speculations are the promises of the technology that underlie all these cryptocurrencies, which is the blockchain technology.

In 2008 Satoshi Nakamoto described in his white paper (Satoshi Nakamoto 2008) the basic principles of a blockchain infrastructure. Although the first implementation was up and running already in January 2009 it took a long time, until approximately 2015, before the blockchain and cryptocurrency idea received an uptake by a larger community as well as the general public. Nowadays blockchains are not just considered as a new technology but also as the enabler for a new generation of a WWW or internet of trust, i.e. the 4$^{th}$ generation after the internet of information, followed by the internet of service and the internet of things (Iansiti and Lakhani 2017).

This assumption is based on the following properties of a blockchain:

- The blockchain technology enables a consensus building within a network of peers instead of consensus provision by an intermediary or a central platform. Thus, it enables a trustful cooperation within a network without the need of a centralized authority that provides a trusted stakeholder service.
- All transactions stored and managed by a blockchain are irreversible and comprehensible. This makes a blockchain very suitable to store transaction data that must be auditable and it can support cooperation processes between network partners who do not trust each other per se.
- A blockchain enables the transfer of values and rights without the need of a trusted 3rd party, thus it provides a notary functionality
- Smart Contracts, which are code snippets that are an integral part of a transaction enable the execution of "contracts" between cooperation partners and may form a basis for a shareconomy.

Interestingly, some of these properties are also relevant for cooperation support applications or touch upon CSCW research. The next section explores these aspects.

# Relationship of Blockchain and CSCW Technologies

## Proof of Work and Consensus building versus Operation Transformation

A blockchain network is built upon a peer-to-peer network of so-called mining nodes. These nodes exchange information about submitted transactions, but they also compete for the right to validate transactions in a new block that is accepted by the other nodes and then added as a new block to the global blockchain (Christidis and Devetsikiotis 2016). In most of the current blockchain implementations this consensus building is based on so called proof of work algorithms (Abadi et al. 2005). One aim of this algorithm is to ensure that the mining nodes that compute the next block are randomly selected by solving a crypto puzzle. An important property of this crypto puzzle is that it is asynchronous, i.e. it requires a certain amount of work to solve the puzzle, but once it is solved, other partners can quickly check that the solution is correct. Since this approach is not only time consuming but also very energy consuming, a lot of research is undertaken to find alternative methods such as proof of stake or lottery based approaches (Prinz et al. 2018). Nevertheless, all of these approaches aim at the selection of a single mining node that gets the right to serialize all transactions in a block for being added to the global blockchain. Furthermore, the approach must guarantee that none of the network nodes is able to add manipulated information. In distributed systems this problem is also known as the Byzantine generals problem (Lamport et al. 1982).

CSCW research has dealt with a similar problem in the context of shared editing. First solutions have already been presented in (Ellis and Gibbs 1989) and later in (Ellis et al. 1991) with the development of operation transformation algorithms such as Grove. Until today this research strand is active within the CSCW community (MacFadden et al. 2017). In fact, all these operation transformation approaches can be considered as a consensus building approach and thus they become relevant in a blockchain context.

The main difference between the blockchain and the CSCW approach is the consensus finding approach. Blockchain consensus is based on a competition between the networked nodes. Once a node has identified a possible serialization of transactions, it is checked and accepted by the other network partners. Operation transformation methods achieve consensus about the correct serialization of transactions by a distributed algorithm that takes the context of the transaction origin into account, e.g. by using state vectors.

Therefore, CSCW research may be able to contribute new solutions or even early day solutions such as (Dourish 1996) towards consensus building in a blockchain. This can be based on a proof of collaboration awareness, using a distributed algorithm that validates transactions based on their cooperation context, such as operation transformation. The goal should be to overcome the current limitations inherit to the proof of x algorithms with respect to performance and scalability.

## Irreversible Transactions, Smart Contracts and Workflow systems

The blockchain data structure, in combination with consensus building methods, ensures that transactions stored in a blockchain become irreversible. For notary-like applications, this is an essential prerequisite. Since smart contracts are an integral part of a transaction, they become as irreversible as the transaction itself.

Experiences with the development of CSCW systems have already taught us from the very early days that successful cooperation systems can only be build using participatory and user centric design methods (Prinz et al. 1998), (Holtzblatt and Jones 1993).

This raises the dilemma between irreversible software and an evolutionary design approach. One solution might be to develop methods to check the correctness of smart contracts (Osterland, Thomas and Rose, Thomas 2017). However, even a correct smart contract may become problematic if the organizational context or cooperation environment was changed or developed towards a new direction. Therefore, smart contracts must be adoptable to new regulations, environmental conditions or even exceptions.

This discussion is similar to the early discussion with respect to workflow systems and their ability to support exceptions (Kreifelts et al. 1991), to evolve with changing organizations, or to support vage cooperation processes (Herrmann and Loser 1999). As a suitable answer to these problems, CSCW research often followed the path of providing a cooperation media instead of a predefined cooperation process (Bentley and Dourish 1995), (Gräther et al. 1997).

Applying this approach to the design of smart contracts would result in the following guideline: smart contracts should only represent very simple building blocks governed by more flexible coordination systems that can be adopted to organizational requirements. This would result in a two layer based approach. Smart contracts build the bottom layer of irreversible building blocks, while the coordination systems support flexibility by the orchestration of the smart contracts. Smart contracts in this sense can be compared with basic cooperation patterns (Aalst et al. 2003), (Martin and Sommerville 2004), (Herrmann et al. 2003) that can be rearranged flexibly to support more complex cooperation scenarios (Prinz et al. 2009). The Freeflow approach presented in (Dourish et al. 1996) follows a similar direction. This implies that a decentralized autonomous organization (DAO[1]) is no longer being fully build und established by smart contracts but by a combination of smart contracts with a cooperation layer on top. This can add flexibility, but one should also be aware that such a DAO becomes modifiable not just to evolve with an organization but also it can be manipulated for malicious reasons. A solution to overcome this problem is a versioning of this cooperation layer in combination with securing the integrity of the layer by a representation as a transaction in a blockchain. This enables a proof of the invulnerability of the cooperation layer by comparing its current status with its representation in the blockchain.

## Blockchain and Reputation Management as a Foundation for a Shareconomy

Beside managing transactions, a blockchain is also suitable to manage identities. The combination of identity management with irreversible smart contracts provides the basis for trusted cooperation processes. This is because, as soon as two cooperation partner have agreed on a smart contract to manage the cooperation transactions, nobody will be able to change this smart contract later on. For example, if the smart contract prescribes a payment after a particular transaction in the blockchain, this payment will be initiated automatically and cannot be obstructed by any of the involved partners. Thus, people can trust in the exact completion of the agreement encoded in the smart contract.

In CSCW and community systems this trust is often achieved by recommendation and reputation management systems (Collier and Hampshire

[1] https://en.wikipedia.org/wiki/Decentralized_autonomous_organization

2010). The rise of platforms such as Airbnb is also an indicator that people are willing to share if someone provides a secure and trustful process. Platforms can achieve this by providing a reputation management and by taking risks (loss of payment, etc.) away from the users. A blockchain replaces this organizational trust management by the algorithmic management of the process. Nevertheless, a blockchain can also support the traditional reputation management approach that is often based on user recommendations such as "likes" by a comprehensible provision of a user's transaction history.

In summary, a combination of CSCW technologies (reputation and recommendation) with the inherent properties of a blockchain can be a solid foundation for decentralized shareconomy networks.

## Affordances of a Blockchain

In the early 90's CSCW researchers explored the opportunities of media spaces for the cooperation and awareness support of dislocated users (Mackay 1999). An important aspect that media space research introduced into CSCW is the concept of affordances (Gibson 1986). In (Gaver 1992) the affordances of media spaces are described as: "Media spaces convey visual and auditory information between arbitrary points, and thus afford remote collaboration".

The blockchain technology is considered as the enabler of the internet of trust (Tapscott and Tapscott 2016). The following items are a result of applying the affordance concept ("properties of a technology that offer actions to appropriate organisms") to blockchain properties.

A blockchain

- makes transactions irreversible, thus affords comprehensiveness,
- support consensus in a network, thus affords community based agreement,
- enables the transfer of values and rights without the need of a trusted 3rd party, thus it provides a network based notary functionality,
- supports autonomous actions by smart contracts, thus affords coordination.

In summary, we can argue that a blockchain conveys comprehensiveness, community based agreement, a notary function and coordination and thus affords trust and even more provides the basis for a decentralized autonomous organization.

# Summary and Conclusion

This brief exploratory paper identifies in a first approach interesting relationships between blockchain and CSCW technologies. The following table summarizes the findings and proposes a combined approach (CSCBlockchain) that aims at combining the better of the two worlds to overcome problems of flexibility, scalability and adoption.

| | **Blockchain** | **CSCW** | **CSCB** |
|---|---|---|---|
| **Consensus building** | Proof of work / proof of Stake; competition based approaches by means of local algorithms | Collaborative editing: operation transformation; context based approaches by means of distributed algorithms | Proof of collaboration awareness based on a distributed algorithm that validates transactions based on their cooperation context. |
| **Smart contracts** | Irreversible program code as integral part of a transaction | Participative and user centric design requires agile software engineering methods. | Understanding smart contracts as cooperation patterns that are governed by versioned and flexible cooperation rules |
| **Reputation and trust** | Irreversible transaction records and smart contracts | User reputation and recommendation | Uptake of the transaction records into reputation management approaches.<br>Building blocks for decentralized shareconomy networks. |
| **Affordance** | Affordance for trust and comprehensibility | Affordance for seamless cooperation | Affordance for trusted cooperation in a decentralized network |

The aim of this paper is to initiate a discussion between the communities of blockchain and CSCW research. Up to now, the communities are disjoint although they both deal with similar cooperation related topics and research questions. Beyond those identified in this paper, further relationships are of interest such as the connection between cryptocurrency mining and reward or recommendation system, or transaction forensics and social network analysis. This paper shall be a starting point to initiate and stipulate this discussion at ECSCW 2018.

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