Blockchain Technology and the Financial Services Market

State-of-the-Art Analysis

HHL LEIPZIG GRADUATE SCHOOL OF MANAGEMENT

Infosys® | CONSULTING

Table of contents

Introduction

For several years, the hype surrounding the distributed ledger approach and blockchain technology has grown steadily, fostering discussions and research activities on potential areas of application throughout the financial services industry. Current research and several use cases reflect the first feasible implementations of the technology, bringing major changes for segments and processes within the industry. An increasing number of banks are realizing the urgency of the topic and are exploring ways of using blockchain technology. A differentiated approach is necessary to elaborate on the potential impacts on industry segments and financial institutions, as blockchain technology is characterized by complexity and several limitations.

Drawing from a broad range of statements from experts from both Infosys Consulting and institutions from various sectors of the industry, this paper provides a high-level business-case viewpoint on the potentials and limitations of the blockchain technology. To that end, both promising and non-promising areas of application are highlighted and discussed.

After an introduction of the technology, three main fields of application have been investigated here: Payment transactions, trade finance and the over-the-counter market. The paper gives an analysis of the status quo in each of these fields and shows where and how blockchain technology could be used or is already deployed. The authors show what is currently done to introduce the blockchain and what the next steps should be.

Background information on white paper

Research on macro level

Identification of relevant areas of application

12 interviews conducted
(8 from banking, 4 from FinTech)

Research on micro level

Deep dive into the identified areas of application

21 interviews conducted
(13 from banking, 8 from Fintech)

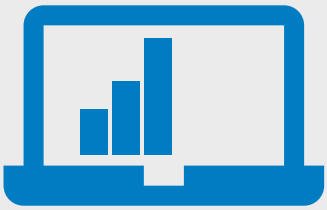
- 81 experts contacted, literature research through more than 70 publications
- 33 Interviews conducted (21 from banking, 12 from Fintech)

Key findings

Blockchain has promising potential in several financial services areas.

1

Investment banking and transaction services are the most promising fields of blockchain application in the near future.



2

Other promising areas for blockchain applications include lending business, insurance, real estate and factoring.

3

Distributed ledger and blockchain are not one-size-fits-all solutions.

4

Blockchain technology is currently not sufficiently regulated and future success will depend on clarifying legal aspects.

5

Collaboration between FinTechs and banks is key for broad implementation.

6

Distributed ledger technology in the financial services industry.

In many of its segments, the financial services industry currently follows a centralized ledger approach, in which trusted third parties process transactions between two or more parties. The central tasks of those trusted third parties are the certification of ownership and the clearing of transactions.

Built for disruption – how blockchain technology works.

Since a decentralized network of computers conducts intermediary tasks over the internet, the distributed ledger approach eliminates the need for a trusted third party (see Figure 1). All transactions are recorded into a digital ledger, which is publicly available and fully distributed to all members of the network (so-called nodes). As each network member holds a valid copy of the ledger, the network itself is able to certify asset ownership and clear transactions, providing a mechanism that offers higher security than the current central ledger approach. Transactions are visible to all network participants and are immutable once they are recorded in the ledger. Moreover, the distributed ledger approach could increase transaction speed and decrease transaction costs, because operations are performed peer-to-peer between the corresponding parties rather than indirectly through trusted third parties.

A distributed ledger system consists of the following five components: (1) a network of nodes, (2) tokens, (3) a structure, (4) a consensus mechanism, and (5) rules.[1]

(1) The network of nodes is composed of the members and computers of the network. Nodes are responsible for the maintenance of the ledger and the verification of transactions. Since the distributed ledger technology is a network approach, it benefits from a high number of nodes. The greater the number of network members working on the verification of the transactions, the higher the mutual processing power. Ultimately, transaction speed and cost structure improve.

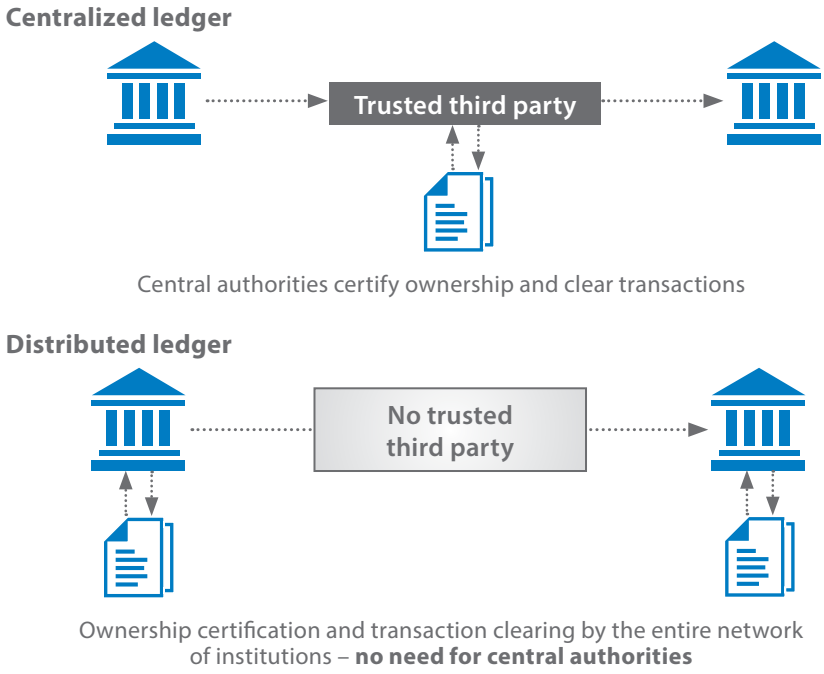


Figure 1: Centralized vs. distributed ledger approach; source: Own illustration based on Santander (2015) and Goldman Sachs (2014)

(2) Tokens are used as unit of exchange/account in distributed ledger transactions. They are mostly referred to as 'cryptocurrency' or 'digital currency'. Some cryptocurrencies (e.g. bitcoin) can be exchanged against fiat currencies. More importantly, tokens can not only be used to account for money; they can also represent any kind of asset, such as bonds, rights, gold bars or even cars.

(3) The structure defines how transactions are stored in the ledger (see Figure 2). Most prominent is a concept called a 'blockchain'. A blockchain consists of electronically chained blocks that contain the transaction records of a given time frame. Since a blockchain sums up all blocks (i.e. all transactions), it represents the whole ledger. In practice as well as here, the term 'blockchain' is often used more broadly to refer to a distributed ledger approach using a blockchain structure.

(4) The consensus mechanism performed by the network of nodes, prevents so-called double spending and determines the 'correct' version of the ledger. Double spending occurs if particular tokens are spent twice, such as when party A owns only four tokens but transfers three tokens to party B and three tokens to party C at the same time. To prevent this issue, the network of nodes has to perform a consensus mechanism to eliminate the manipulation of transactions (see Figure 3, page 7).

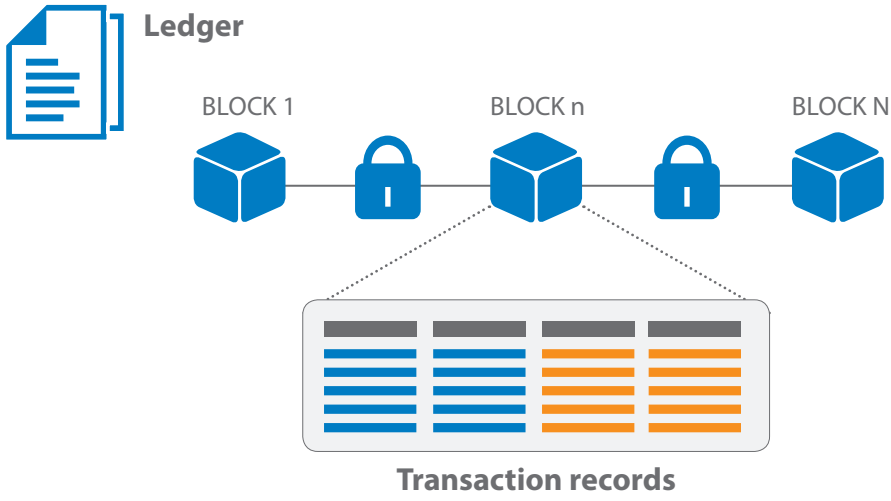


Figure 2: The structure of a blockchain; source: Own illustration based on Bitcoin (2015) and Nakamoto (2009)

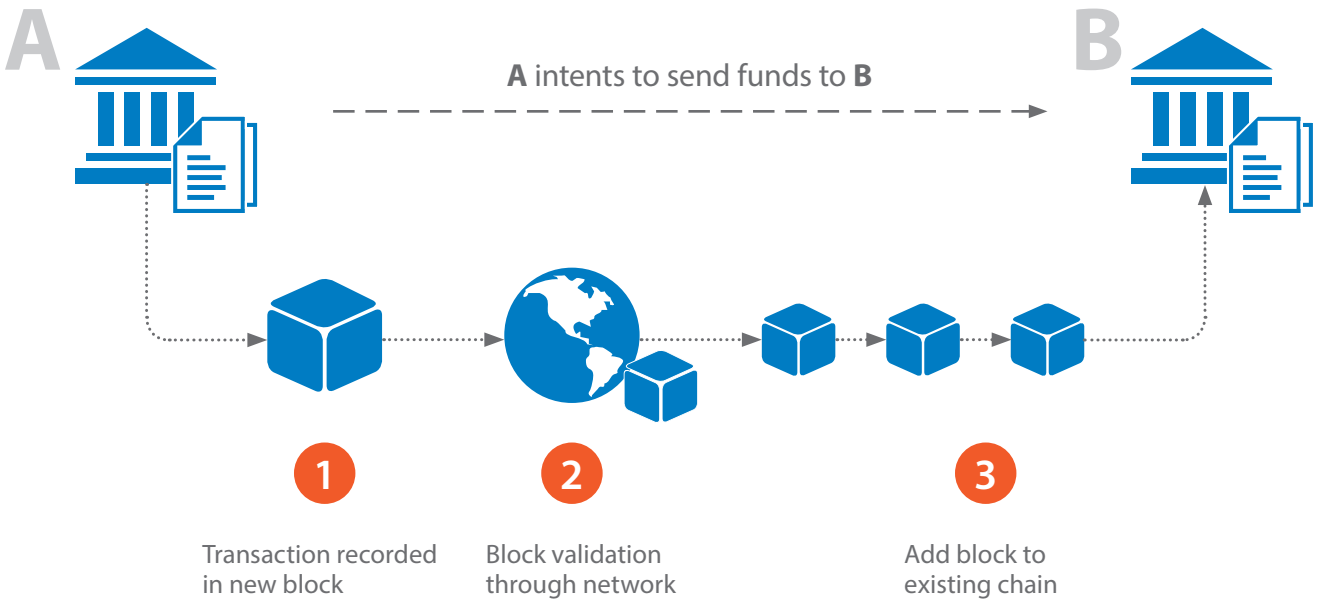
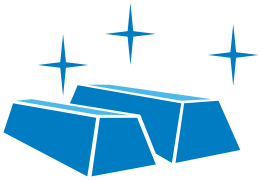


Figure 3: The process of a distributed ledger transaction; source: Own illustration based on Santander (2015) and Goldman Sachs (2014)

The best-known mechanism is 'proof-of-work', which is applied by bitcoin (see Figure 4). The network of nodes has to solve difficult and costly puzzles to add new blocks to the blockchain, i.e. record new transactions in the ledger. This requirement prevents double spending because it would be too costly and computational power-intense for any third party to outperform the whole network in solving these puzzles to manipulate transactions. Another mechanism, called 'proof-of-stake', prevents double spending through the idea of token ownership. The greater the share of ownership of certain network members, the more blocks these members are allowed to add. The assumption is that a member's self-interest not to act fraudulently increases with increasing coin ownership.



PROOF-OF-WORK

- Users **solve puzzles** to mine new block
- This implies **running hash algorithms** to verify transactions

PROOF-OF-STAKE

- Users mine based on **coin ownership**
- High share of ownership implies user's **self-interest**

Figure 4: Proof-of-work vs. proof-of-stake; source: Own illustration based on Accenture (2015), Bitcoin (2015) and ECB (2015)

(5) Rules set out a protocol for interactions between participants. Two of the most influential protocols are seen on the bitcoin and Ripple networks (see Figure 5). Whereas bitcoin is a cryptocurrency with a built-in payment system, Ripple is a payment system for arbitrary assets. The two protocols differ in their consensus mechanism, transaction fee policy, creation of new tokens and other aspects. Hence, rules strongly influence the character of distributed ledger systems and determine the way the system can be applied.

Two Basic Protocols

Bitcoin protocol

- Currency with built-in payment system
- Proof-of-work consensus process
- Mining of new tokens by network nodes
- Only bitcoins can be tracked
- Transactions are basically free

Ripple protocol

- Payment system for arbitrary currencies
- Iterative consensus process
- Ripple Labs issues new tokens
- Any kind of asset can be tracked
- Transactions have an XRP cost

Figure 5: Bitcoin protocol vs. Ripple protocol; source: Own illustration based on Accenture (2015), Bitcoin (2015) and ECB (2015)

No magic potion for everything.

Although the distributed ledger technology has the potential to change and improve the current financial services industry, it does not constitute a one-size-fits-all solution. Potential business cases need to fit to the technology's specific characteristics, which are:

Security: All transactions recorded in the blockchain are immutable and transparent. Therefore, the application of the technology is appropriate for use cases in which security plays a major role.

Decentralization enables business models that replace any trusted third party or intermediary because a trust relationship between unknown parties is established.

Any asset possible: Tokens used by the network allow the exchange of any physical or non-physical asset so that the blockchain can be used for different kinds of transactions.

Internet as basis: The blockchain uses the internet as the underlying infrastructure to process transactions. This enables business cases to provide banking services without the need for a banking infrastructure.

Lower costs, higher speed: In some cases, the blockchain could reduce transaction costs and increase transaction speed. This feature depends mainly on the number of transactions and the network size.

Besides these characteristics, some possible obstacles or limitations have to be mentioned: Since the blockchain technology is a network approach, a certain number of members is required to participate in the network to offset the costs of setting up the blockchain infrastructure. Furthermore, severe consequences of IT instability or human error can interfere with blockchain business use.

Despite technological characteristics and requirements, the application of blockchain technology to business cases requires a solid legal framework that regulates the rights and obligations of all participants and also takes into account the rules, laws and taxes imposed by public authorities. At the moment, legal bodies have just begun to take notice of the technology and are far away from releasing a legal framework. In light of the above, the distributed ledger technology can develop its full potential only if the mentioned criteria are fulfilled (see Figure 6, page 9).

Who is in? The main stakeholders.

Blockchain expertise mainly comes from more than 300 leading FinTech start-ups (FinTechs) spread world-wide. These companies mostly have a deep understanding of the technology since they are already working on first business cases. Although only a few large-market cases presently exist, FinTechs are already generating remarkable revenues. Banks also have a deep understanding of the technology, which arises from their own research as well as from collaborations with other banks, such as R3 CEV, and FinTechs. Research especially occurs in innovation labs or company development departments. In 2015 already, 47% of financial institutions were exploring ways of using blockchain[2] and many globally operating banks are developing their own cryptocurrencies, such as SETLcoin by Goldman Sachs and Citicoin by Citibank. Additionally, banks are investing in blockchain start-ups and publishing the results of their research in the form of articles and white papers. Diverse models of collaboration among all these players are conceivable; one would be that FinTechs operate on top of and in collaboration with banks, serving the broad customer base.

Regulators like the ECB initially focused on cryptocurrencies but are now moving on to further applications, especially in transaction banking. The Bank of England, the Federal Reserve and the Monetary Authority of Singapore conduct the most advanced research. Regulators are aware of blockchain technology's potential to solve problems within regulation itself, such as those related to anti-money laundering (AML), know your customer (KYC), and counter-terrorism financing (CTF). Although regulators have begun dealing with the technology, they are still some time away from enacting a comprehensive legal framework that is capable of regulating the various blockchain applications.

Although banks, FinTechs and consultancies jointly discuss the technology, research is still in an early stage. The majority of activities aim at understanding the technology and its implications for financial services to create the basis for a comprehensive discussion on specific use cases.

Implications for the financial services industry.

Currently, the distributed ledger approach is tackling numerous business areas and processes but does not offer a perfect fit for implementation in every corner of the industry. However, the reach of the technology might increase in the near future, as research is ongoing to extend the performance boundaries.

Limitations of the technology, combined with characteristics of particular areas within financial services, constrain prompt implementation in some business fields. Segments and products that have no collateral behind them generally hold no potential for administration improvement through the implementation of the decentralised ledger technology. Thus, the business areas of agreed overdrafts and discount credits do not constitute prospective areas of application. Currently, the deposit business plays a minor role and shows low potential for a beneficial blockchain use. Although in the future the technology could be employed to secure deposits and better map interest payments, current projects focus on cryptocurrencies and do not indicate an early implementation within the deposit business. In the current stage, cash transactions are precluded, as the focus lies on digital solutions and non-cash transactions. Owing to low margins, retail banking is not presently considered to be a promising field. One major limitation of the blockchain technology is the inability to improve the enforcement of payment titles and map

k-double auction scenarios in several protocol types. Hence, it does not function as a legal authority (except for documentation).

On the other hand, the blockchain technology shows a huge potential for various products, processes and areas within the industry. Three fields of application stand out: **Payment transactions, trade finance and the Over the Counter (OTC) market.**

Within the field of **payment transactions,** the technology could be used to overcome current problems of the correspondent banking system and international money transfers. The fee-intensive and fragmented processes of cross-border, non-cash transactions could be eliminated by the exclusion of third parties, direct money transfers and efficient interbank settlements. The possibility to create a competitive marketplace of liquidity providers potentially ensures the best exchange rates for international exchange and payment transactions.

Second, as **trade finance** is one of the segments in financial services that could not keep up with technological developments and digital evolution, blockchain technology could induce a needed transformation. The current legal situation in trade finance could be transferred to the blockchain, which would create strong legal certainty. The technological capabilities of delivering trust, security, risk mitigation and fast processes at low cost offer true innovation potential.

Third, the blockchain technology could redesign the **OTC market infrastructure** and lead to elimination of obsolete market participants. Huge costs savings might be possible by using smart contracts that could automate the execution of OTC agreements. Direct trade without trusted third parties could be executed, whereby customers no longer need to depend on their brokers. The technology has the potential to reduce settlement risks by enabling almost instant settlements and avoiding latencies of about T+3 days to settle.

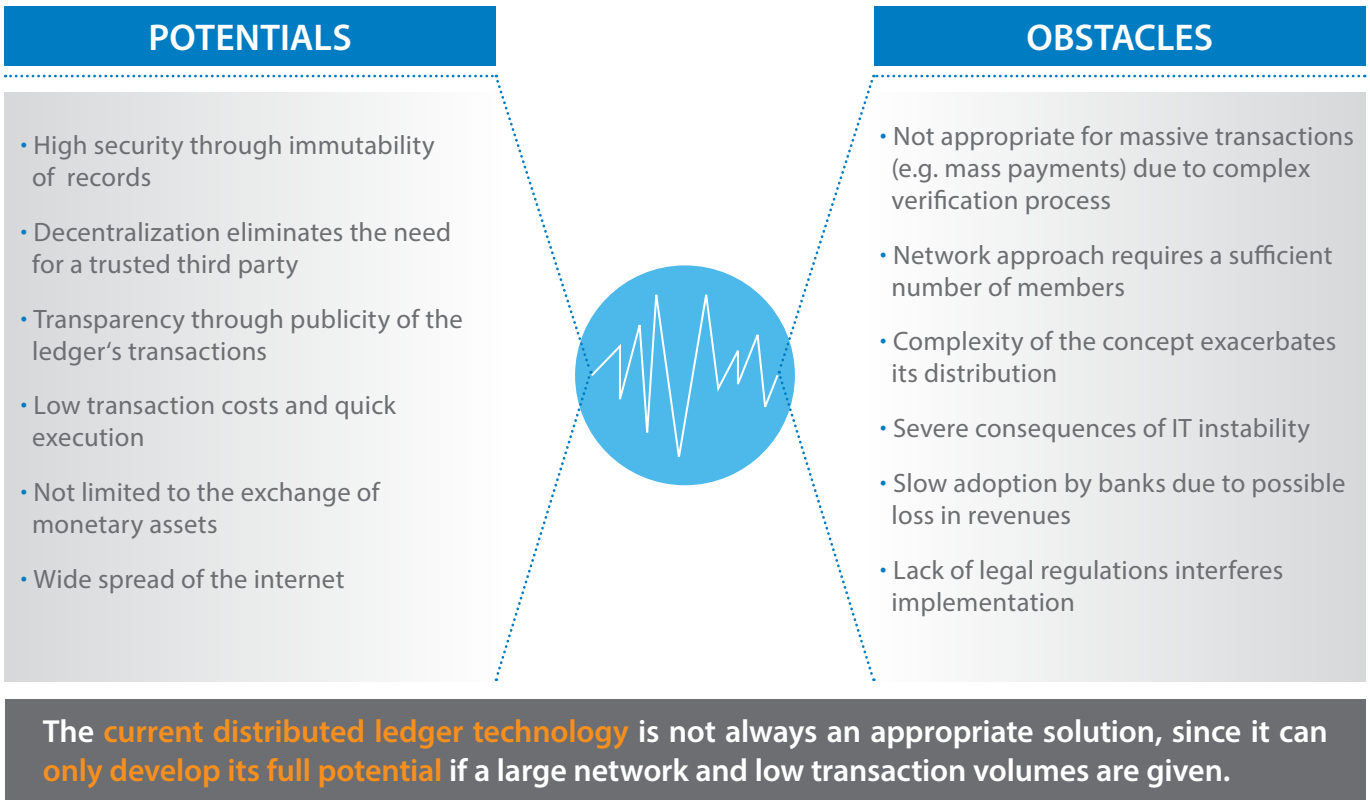


Figure 6: Potentials and obstacles for applications; source: Own illustration based on expert interviews (2015) and analysis results

1) Payment transactions.

Payment transactions constitute a major business area of global transaction banking and involve the administration of liquidity in any currency for companies, individuals and financial institutions. Over the last decade, global payment revenues have increased sharply, and forecasts indicate a further rise. The numbers of global and European non-cash payments are also constantly growing and expected to further increase (see Figure 7). In 2015, the share of global non-cash transactions was 20%. The contribution of payment revenues to total banking income has been increasing steadily and is expected to remain at a mid-term level of 40%, with the trend toward revenues being driven mainly by fees and not by interest.[3]

To transfer funds internationally, banks lacking a correspondent relationship depend heavily on other correspondent banks. Thus, they have to establish a process that involves a chain of banks and incurs transaction, third-party and exchange rate fees, accruing for each player within the settlement process. This practice often creates cryptic transfer routes and overlapping processes and is further complicated by diversity in the clearinghouse memberships of banks (see Figure 8). Payment systems are based on local laws and practices within existing domestic banking. The lack of a common global standard

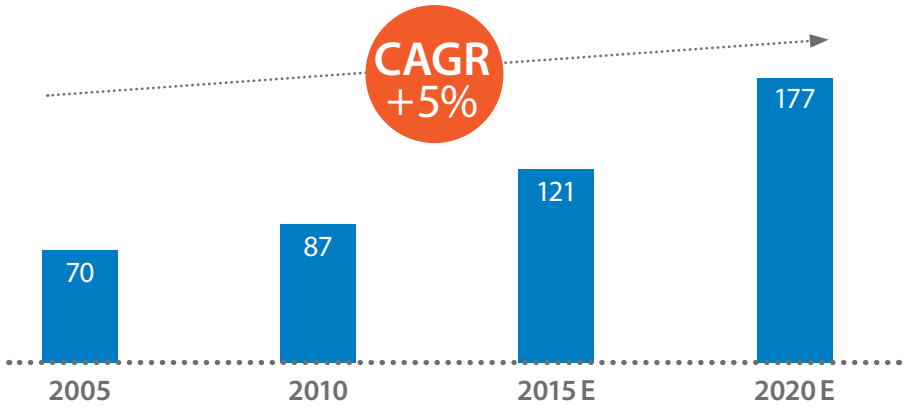


Figure 7: Number of non-cash payments in Europe from 2005 to 2020 (in billion transactions, no ATM transactions included); source: A.T. Kearney (2013)

reduces the ability to seamlessly pass data and back-office information and creates both settlement and non-settlement risks.

Despite all the mentioned obstacles, international payment systems have become increasingly more efficient during the past decade. Improvements include offering the ability to settle cross-border payments within 24 hours and, in countries like the UK, introducing first real-time payment systems. Nevertheless, an appropriate potential for improvement of legacy system processes must be developed soon to meet future industry demands.

Cost and complexity reduced.

The deliverable performance of a technology often depends on whether it can be modified and improved through further research. With respect to payment systems, determination of this possibility involves an analysis of certain requirements the blockchain must meet to be ready for implementation. Primarily, the technology must prove superior to current processes and must add value in terms of lower transaction times, costs and efforts per payment transaction, simultaneously guaranteeing high security standards and satisfaction of regulatory requirements for all involved parties. Analysis of this evidence can disclose fundamentally different results across various financial institutions, and a differentiated and individual consideration is necessary before implementation starts. The requirements for a mass implementation fall into two broadly defined categories: the legal aspects, which present the major hurdle for most

1. **Company A** (USA) needs to make a payment to **company B** (Japan) – **company A** requests its bank (**bank A** – USA) to send a U.S. dollar payment to **company B**
2. **Bank A** does not belong to the corresponding **clearing house** – has to request its correspondent bank (**bank B**), which is a member of **CHIPS**, to facilitate the transfer; **SWIFT** message from **bank A** to **bank B**
3. **Bank B**, a member of the **clearing house**, sends the funds transfer command to the **clearing house**
4. The **clearing house** executes the fund transfer by crediting the account of another U.S. **clearing house** member **(bank C)**
5. **Bank D** in Japan is **bank C's** correspondent bank and receives payment from **bank C**; **SWIFT** message from **bank C to bank D**
6. **Company B** has an account with **bank D** and receives the funds

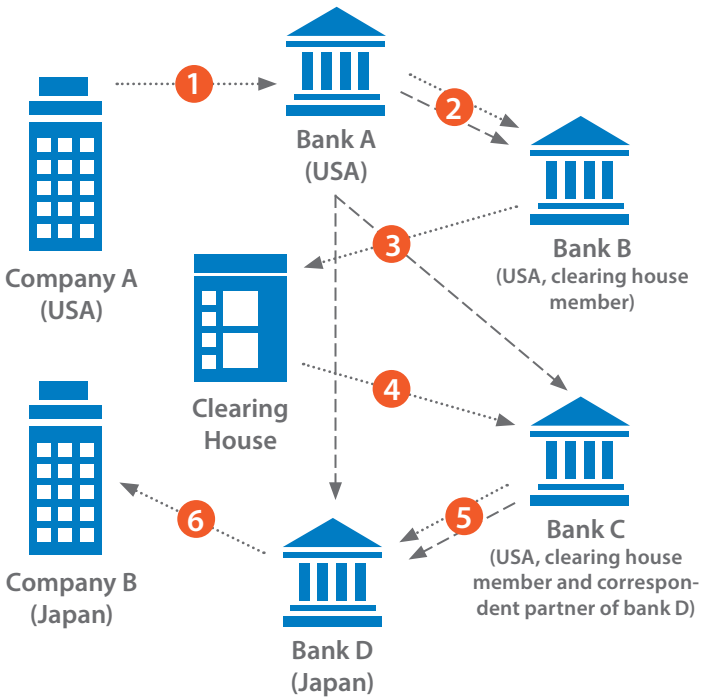


Figure 8: Example of an international payment transaction without blockchain; source: Expert interviews (2015), US Department of Treasury (2007) and VISA (2006), Illustration adapted from 'The Inefficiencies of Cross-Border Payments' by VISA (2006)

Banks are verified partners within a **peer network** that uses a **private** Block-chain solution with private keys.

Each member of this Block-chain platform can send **funds and information** directly to other members, open market principle guarantees **lowest exchange rate fees.**

Information and back-office data is saved and integrated into each block of transaction.

Ripple transaction protocol (RTXP) can serve as a central protocol which allows members to conduct cross-currency transactions in **3 to 10 seconds.**

1. **Company A** (USA) needs to make a payment to **company B** (Japan) – company A requests its bank (**bank A** – USA) to send a U.S. dollar payment to **company B**
2. **Bank A** directly executed the fund transfer to **bank D** via the Blockchain protocol (information and back office data is stored in the blockchain)
3. **Company B** has an account with **bank D** and receives the funds

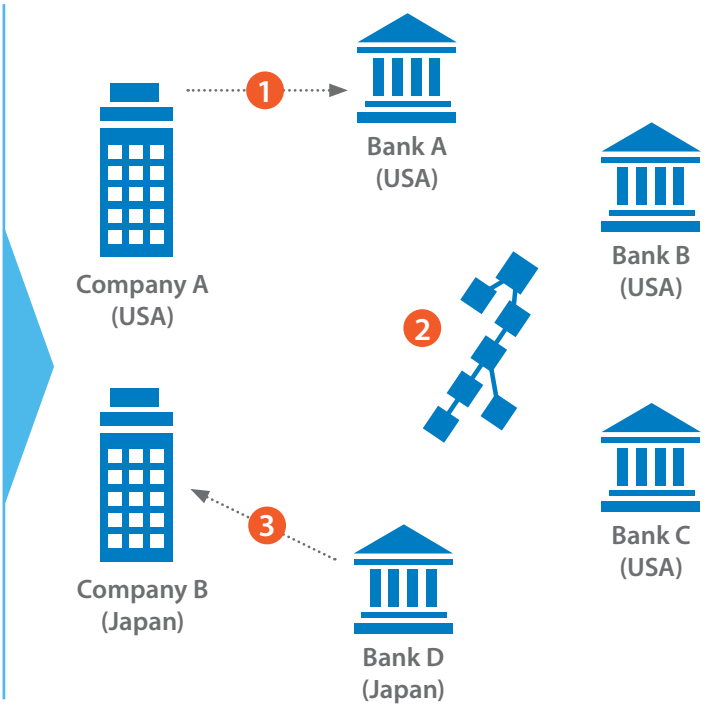


Figure 9: Example of an international payment transaction with a blockchain; source: European Payments Council (2015), Ripple (2015), expert interviews (2015) and analysis results, own illustration based on expert interviews (2015) and analysis results

of the participants, and the technological aspects, which have to be guaranteed at any time.

Legal requirements: Legal arrangements should be defined for the insolvency of a blockchain participant, liability for enforcing anti-money-laundering standards (AML), and managing over-lapping jurisdictions. Furthermore, legitimation aspects and procedures must be considered, such as the identification of beneficiary parties and politically exposed persons (PEP's). Legal ambiguity constitutes a major hurdle for implementing the block-chain in international payment systems, as many aspects remain to be clarified.

Technological requirements: Certain technological properties are vital for broad use. The screening of beneficiary parties needs to be adjusted and extended to IP addresses and block-chain accounts – a requirement that should be put into practice without any major problems.

The most promising fields of application within payment systems seem to be individual transactions and cross-border payments of different volumes, which can be large corporate and inter-bank transactions. Initial concrete approaches within cross-border payment processes state the potential advantage of broad peer networks consisting of verified partners, such as banks. These networks could employ a private blockchain solution, allowing each member to send funds and transaction-relevant information directly to other members.

Making use of the technology in such a way could change the course of the prevailing correspondent banking system. International payment transactions could be executed by omitting the use of third parties like clearinghouses and to a large extent the branched chain and cross-transfer of information and funds (see Figure 9). This principle of implementation could theoretically be beneficial for national payments as well. Blockchain technology could therefore serve as a perfect means for account settlements within book transfers.

The key benefits would clearly be cost reductions owing to the elimination of transactions, and data processing could be shaped much more efficiently. International and domestic money transfers and cross-currency transfers would become much faster, and a time and cost reduction due to 24/7/365 real-time settlement availability, simplified transactions and automated accounting adjustments would potentially be possible via the blockchain and thereby constitute a major improvement.

At present, the detailed scope of impact and cost-saving potential in the case of such well-functioning global blockchain payment systems is not possible to estimate because of the unknown implementation costs for financial institutions. Also unknown is how certain banks might delay the process of implementation by resisting changes owing to the fear of losses in chargeable transaction fees.

Ripple Labs,[4] a San Francisco-based venture-backed start-up, is currently doing research in exactly this field. The self-developed Ripple transaction protocol (RTXP) can serve as a central script, which aims at allowing members of such a network to conduct cross-currency transactions within 3 to 10 seconds.[1)] Through RTXP, every member can take advantage of the lowest prevailing exchange rates, as an open-market principle creates a competitive set-up for liquidity providers and guarantees the lowest exchange rate fees for transactions. The cryptocurrency Ripple XRP constitutes an optional bridging currency between all tradable currencies and can be used by each member of the network. Although the Ripple network is constantly growing and developing, the scalability of the Ripple protocol and the usability of the bridging currency have not yet been tested.

[1)] Principle can also be beneficial for national payments and the blockchain can serve as a perfect mean for account settlements within book transfers.

Promising examples on their way.

Although applied use has begun, the overall process of blockchain implementation within payments is still focused on prototype testing.

Nevertheless, potential areas of application increasingly arise.

Some examples from FinTechs as well as banks:

Bitpay, an Atlanta-based start-up, allows customers to accept payments in bitcoin and to receive funds directly into their bank accounts.

SatoshiPay, a Berlin-based start-up, is investigating the area of nanopayments via the blockchain, and early results suggest complete new service models like the proportional payments for magazine article paragraphs.

BNP Paribas is currently testing an internal bitcoin integration in currency funds.

The Royal Bank of Scotland is about to start a pilot Ripple protocol program.

Citibank and UBS are currently developing and testing their own cryptocurrencies.

The German Fidor Bank has established a partnership with Ripple Labs to provide customers with money transfer services in multiple currencies at a lower cost.

Moreover, banks are heavily investing in and collaborating with FinTechs, as they are known for having a deep understanding of the technology, while establishing additional internal research labs. Networks of FinTechs, banks and other financial institutions are emerging and growing as players understand that joint research and testing of the technology is most efficient. R3 CEV, probably the most popular FinTech and consisting of more than 50 different financial companies, is currently setting up a hermetically sealed market and ecosystem to test-run products and processes in various fields. Financial institutions like SWIFT and VISA realized that their business models might be soon in grave danger and are engaging in research so as to play a major role in a potential future of blockchain processes. Regulators are aware of the technology's potential to solve problems within regulation itself and strongly focus on requirements within global transaction banking in the course of piloting and implementation. The urgency of the need for action is growing.

What's next?

A broad implementation and use of the blockchain technology would change and disrupt the financial services industry and payment systems on an international scale. Processes would alter in terms of time required, and the revenue models of many financial institutions might become obsolete. The technology has the power not only to shape payment and settlement processes more rapidly, cheaply and safely, but also to redefine the entire system of international money transfers. However, to ensure broad use in the future, major limitations need to be addressed, and the properties of the technology have to be further developed and improved.

2) Trade finance.

The International Chamber of Commerce (ICC) estimates that today between 80% and 90% [5] of international trade uses trade finance products. In absolute figures, this percentage corresponds to a trading volume of around $14 trillion.[6] Hence, the slow pace of innovations in trade finance is surprising. This lag is mainly due to the lack of technological solutions to some of the core problems in international trade:

Manifold risks inherent in international trading contracts can result in insecurity, mistrust and low trading volumes. In addition, long distances, different languages and the unknown solvency of the trading partners all hamper the flow of goods across borders. These challenges create the need for financial products that provide adequate levels of both security and liquidity. As financial services aim at balancing differences between trading partners and at minimizing risks, banks are backing trade relations with

guarantees,

insurance on open account transactions,

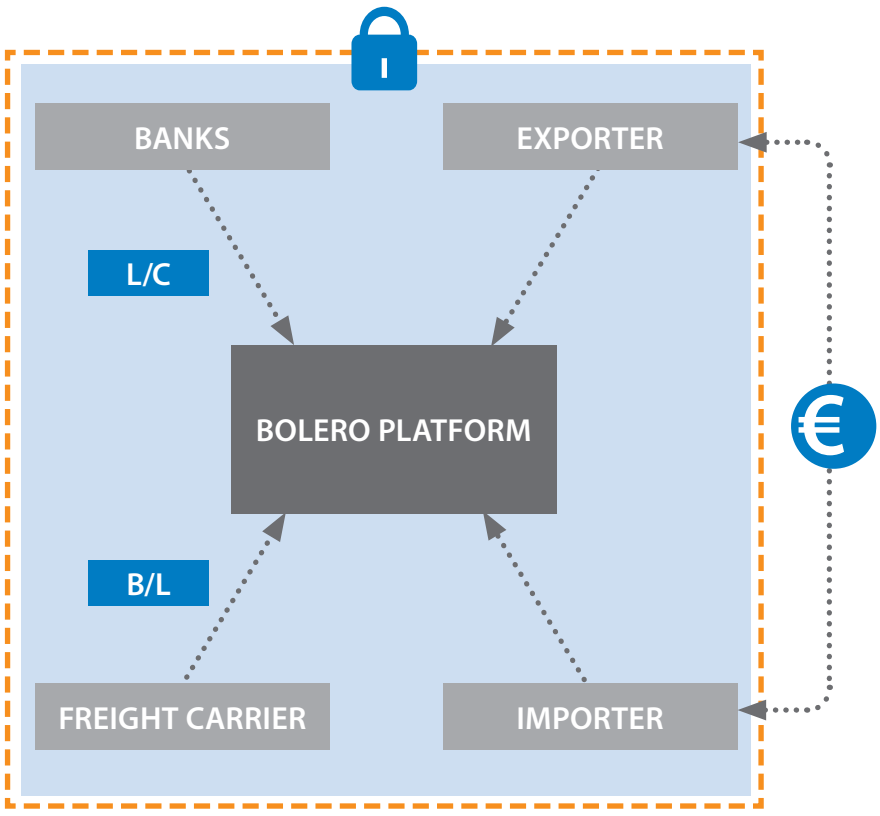
standby letters of credit (SBLC)

and payment promises like the letter of credit (L/C).

For centuries, the core of these products has been the same. Processes are still manual and largely based on paper documents. Despite its immense value for the creation of trust between trading partners, the L/C has lost in significance because it could not keep pace with the increased speed in trade transactions. It is surprising, for instance, that now the possessor of a bill of lading (B/L), which is a paper document, has the power of disposition over the traded goods. In large part, international trade is therefore processed on an open account basis, which implies either an increase in cost or insecurity for the trading partners in comparison to the L/C.

Nonetheless, digitization has begun to make its way into trade finance and has generated first attempts to reduce costs and cycle times. Examples of this development are the company Bolero and the bank payment obligation (BPO) (see Figure 10 and 11).

Despite the progress to date, a break-through innovation in this segment is still to come. Currently no solutions exist to core problems, such as a digital representation for the transfer of ownership or an automated checking of L/C conditions. Fraud via double financing or the scarcity of trade finance products in developing and emerging markets are further issues that cannot be fixed with the limited closed-shop architecture of current digital products.



Bolero is a platform-based trading environment that allows trusted parties to exchange documents online while adhering to an internal 'rule book'.[7] Although this network is over 12 years old, with 6 million trade documents per year worth 80 billion USD of trade transactions.

Figure 10: Bolero platform; source: Own illustration based on Bolero (2015) and expert interviews (2015)

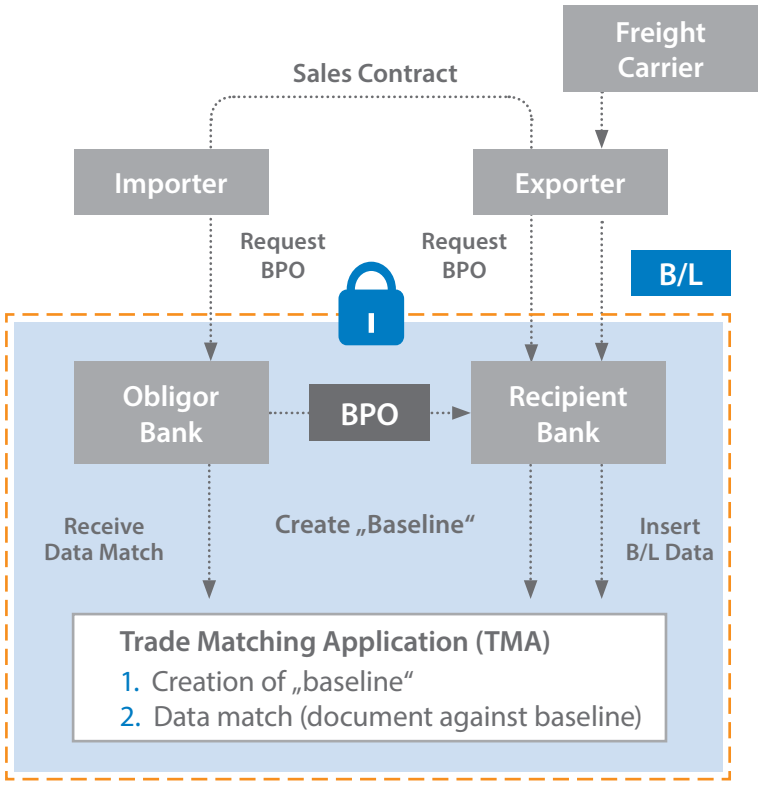
No trade-offs – speed and security combined.

To deliver noticeable value, blockchain-based solutions have to address the different needs of trading partners, financial institutions and freight carriers. Moreover, certain legal and technological requirements must be met. Especially for trading companies, low barriers to entry like the elimination of fixed costs are important to allow widespread adoption. High security and privacy standards are also a basic prerequisite in international trade. Beyond that, the trading sector – or at least parts of it – is in need of a means to eliminate counterfeit products from international markets. Standard trade finance products are usually characterised by a trade-off between low cost and high security. Now, for the first time, a technology can overcome this trade-off while offering the possibility of collaboration in a secure way over long distances at low process-related costs.

There are two major requirements though, that have to be met for blockchain technology to show its full potential:

Financial services requirements: From the financial services perspective, it is critical to create a global marketplace for the offering of trade finance products. Such an open-shop solution would intensify competition, efficiency and product transparency. Moreover, a flawless exchange between financial institutions, like trade with guarantees, payment titles, loans, securities, would provide space for the optimization of risk strategies and liquidity management. An improvement in current processing is also urgently needed. Today, for example, the operational processing of a L/C consumes considerable time owing to manual work and bureaucracy. A reduction in those efforts would decrease cycle times and improve the cost structure of trade finance products. However, the abolition of paper documents and the implementation of digital equivalents would have advantages beyond process efficiency. The ability to guarantee the origin and uniqueness of an invoice and its associated asset would dramatically reduce the damage caused by double financing.

Legal requirements: Concerning the legal framework of possible blockchain solutions, existing laws and standards will inevitably be transferred to the blockchain. Adherence to common trading standards, like ICC UCP 600 for the L/C, and legal standards would increase the probability that such a platform or blockchain-based products are accepted by a broad audience. Therefore, during the development of such solutions, integration of important trading institutions should be considered, for example ICC, IMF, WTO or the World Bank.



The BPO is a young, promising bank-to-bank instrument, supported and developed by the ICC and SWIFT. An ICC standard for this instrument (URBPO) was introduced in 2013. The product is based on an inter-banking communication platform called the trade matching application (TMA).

The core of the TMA is a matching process of predefined trade data (the 'baseline') and B/L data. The match allows the obligor bank to guarantee the payment (i.e. issue the BPO) to the recipient bank, and the sending of a paper-based B/L is no longer required. Currently, the BPO is said to be the most advanced digital product in trade finance.

Figure 11: BPO framework; source: Own illustration based on SWIFT (2015), ICC (2014), Wolf (2013)

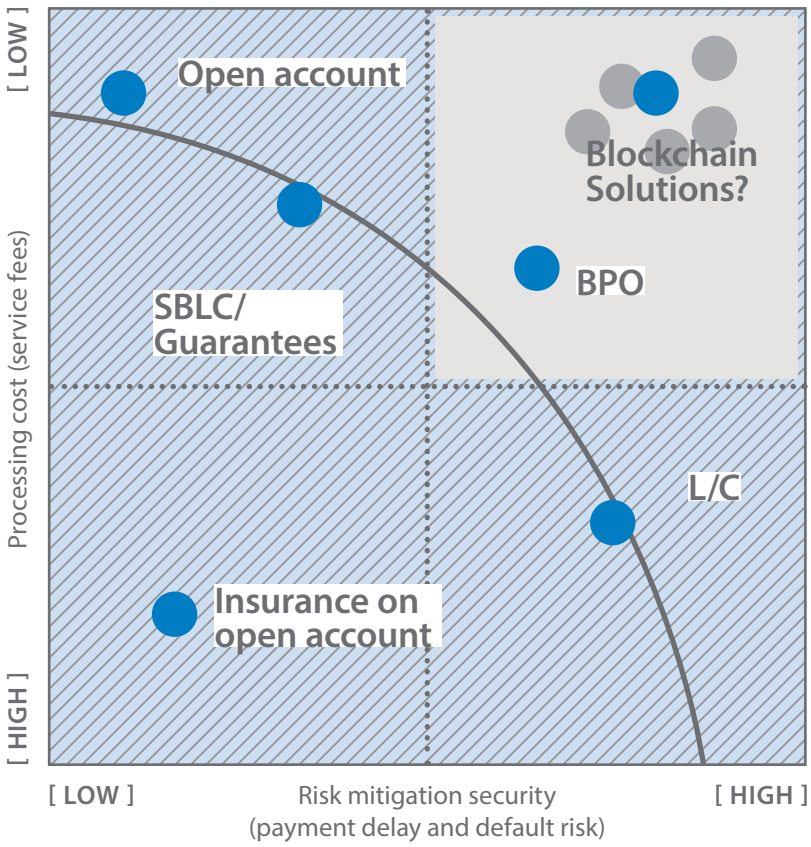


Figure 12: Trade finance products; source: Illustration slightly adapted from 'BPO - a corporate prospect on supply chain finance' by M. Diaz / SWIFT (2012)

Possible use cases in trade finance.

Asset tracking is one of the use cases that can be implemented in many different ways. Having an asset with a unique serial number secured in a blockchain can guarantee authenticity and origin of a good. The buyer of a good can verify the serial number against the immutable data in the database and can be sure of having a genuine product. Especially industries in which counterfeits are common, such as the medical sector, could strongly benefit from the creation of a secure product history. For industries with opaque production and transportation, like coffee, cocoa or textiles, blockchain technology could assist end consumers in making correct purchase decisions and in distinguishing, for instance, between fair and unfair labor practices. Combining asset tracking with other technologies and use cases like GPS, RFID or smart contracts may lead to an advanced, automated and secure flow of goods.

Smart contracts are a use case that is likely to become an inherent part of future trade finance products. The idea of smart contracts pre-dates blockchain technology and is simple in its core. In combination with blockchain technology, it becomes valuable as an agreement between two parties and can be secured in a distributed ledger. The execution and fulfilment of contract conditions can ultimately be automated. Manual document scanning becomes obsolete and legal conflicts can be reduced. For a smart contract, a (legal) condition is transferred into a query that automatically checks the conditions' fulfilment. In the case of fulfilment, a predefined measure, like the transfer of money or sending of a message, is taken. Such a signal could be the entry of a good's serial number by a third party. For example, the freight carrier taking over the goods from the seller could enter this information into the system and thereby initiate the payment. An approach like this could replace the process of sending a paper B/L from one institution to another.

Many blockchain use cases imply that banks or other third parties become obsolete in their function as an intermediary or trustee. While the technology is able to make processes easier and flawless, in trade finance it is not able to take over the role of financial institutions. In cases of default, banks are still needed to cover the buyer's or seller's investments.

Current projects: collaboration is key.

Since blockchain technology becomes valuable when it is adopted by many participants, the attempts at collaboration between start-ups, banks, consultancies and authorities are promising. An analysis of all the different projects that are currently underway reveals that projects concentrate either on improving a trade finance product or on solving a specific value chain problem. Some examples:

Singapore's DBS Bank [8], for instance, collaborates with Standard Chartered and Infocomm Development Authority of Singapore (IDA). The consortium conducted a proof of concept (PoC) to reduce double financing in trade finance (secure invoicing).

Start-ups like Chronicled, Provenance or Thingchain [9] are using the idea of asset tracking to reduce counterfeits, for example in the sneaker, wine and medical industries.

The Singapore-based start-up **Open Trade Docs** [10] aims at digitising trade documents (e.g. invoices) and securing them in the blockchain. At the moment, the company is in the PoC phase with financial institutions.

Wave, a FinTech in Israel and part of the Barclays Accelerator, works on a digital, blockchain-based B/L.

The London-based company **Everledger** [11] is well advanced in asset tracking (see Figure 13). The company secures a unique serial number that is laser-engraved in a diamond to guarantee that the stone is conflict-free. Moreover, origin and ownership of the stone can be verified. Such a fingerprint of an asset that is reliable and secured in a blockchain provides valuable data for buyers, traders, insurors and authorities.

Digitising, securing and automating the L/C are the goals of the company **Skuchain** (see Figure 14, page 17). Its product is called 'Bracket', which is an acronym that stands for 'blockchain-based release of funds that are conditionally key-signed and triggered by signals'. A federated blockchain, which is a private blockchain with trusted external nodes, is the platform on which all parties can interact and use the bracket. The bracket is basically the transfer of the sales contract conditions, especially delivery and payment, to smart contracts. To guarantee high security, the smart contracts are additionally secured in the bitcoin blockchain. The most remarkable aspect of Skuchain is its collaboration with banks for the automating of payments.. The company established an interface between the crypto world of blockchain and the previous world of fiat currencies. The verified information ('signal') that is entered into the database, like the B/L data, causes real transactions between bank accounts.

Although the currency may not have a great future for trade finance, the bitcoin blockchain is still the largest and thus the

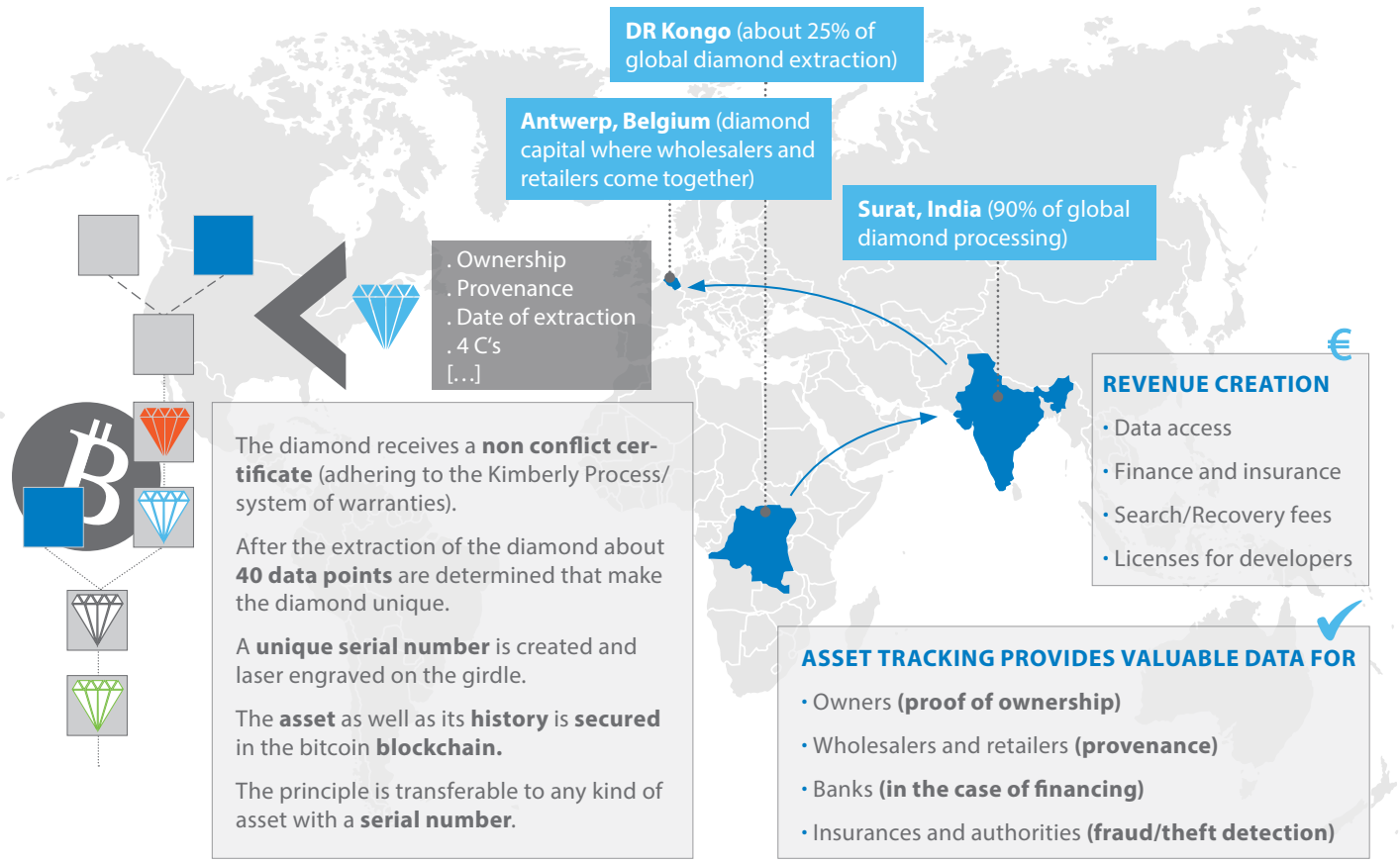


Figure 13: Everledger's diamond tracking process; source: Own illustration based on expert interviews (2015) and Everledger (2014)

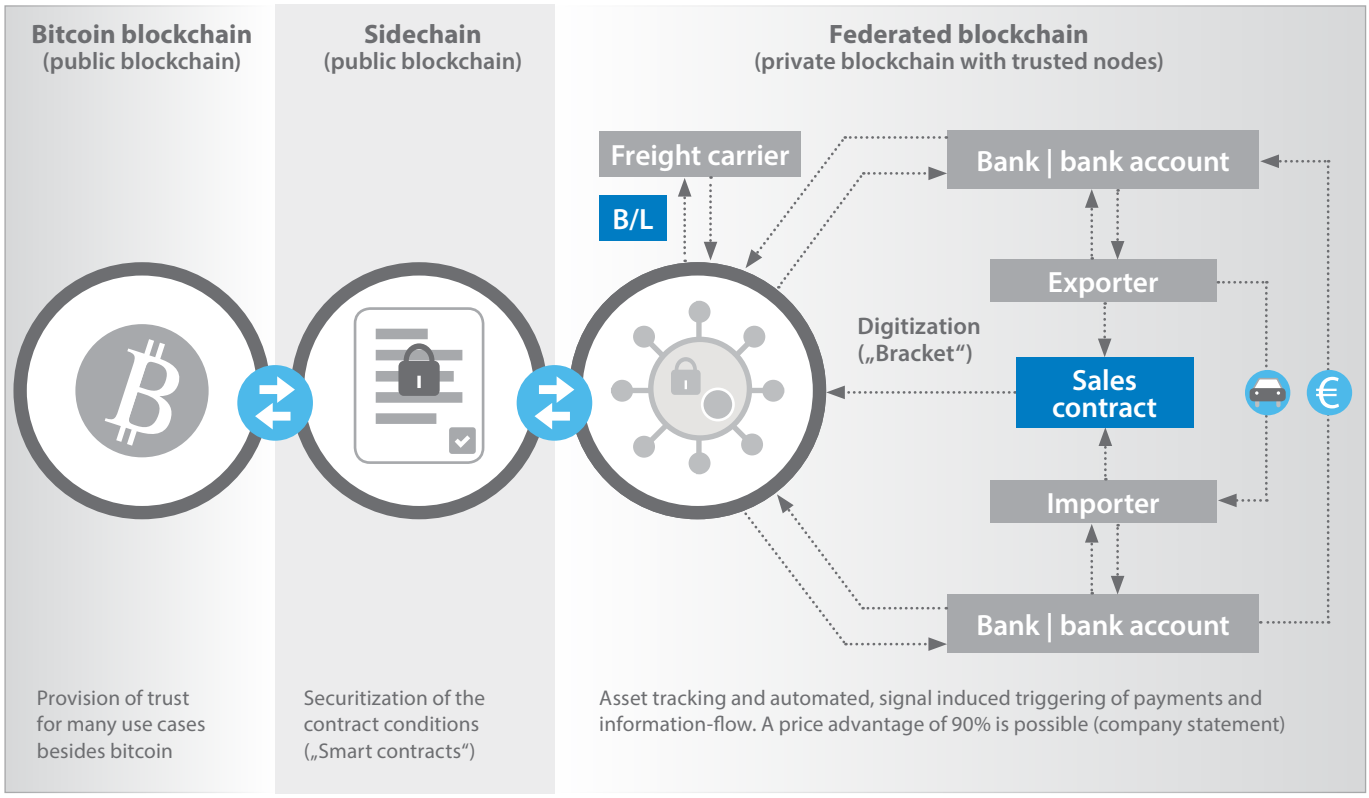


Figure 14: Skuchain's Bracket [2] ; source: Own illustration based on skuchain (2015) and expert interviews (2015)

most secure distributed ledger. Therefore, many FinTechs use it to secure their data with bitcoin transactions. The sidechains of the bitcoin blockchain or the colored coin principle are favoured for consigning contract conditions or tracking assets.

What's next?

At the current stage, it is hard to predict who of the different players will be successful and whether it is possible to establish an international blockchain platform for the exchange of documents and trade finance products. Success of individual companies will strongly depend on effective networking and openness to collaboration. Most of the currently promising projects are based in some way on collaboration models, and banks will have to accept that expertise and deep technological understanding cannot be found solely in-house. In contrast, FinTechs are in need of the customer base and the industry knowledge of financial institutions.

At the moment, many banks are exploring ways to make use of the technology and its possibilities. Only a few presently emphasize trade finance. Some financial institutions have taken an observer position, waiting for the right time to invest. However, the wait and see strategy appears risky as the know-how, which is currently building, becomes more valuable. The entire FinTech and blockchain environment is fast-moving, and according to several experts, block-chain technology will reach mass suitability within the next 5 to 10 years.

During the maturing of the technology, a market entry could become costlier. Current projects will stabilize and start to generate revenues, leading to an increase in investments in start-ups, infrastructure and know-how. In addition, major trade institutions like the ICC and the WTO will approach blockchain technology on a broader level. As a result, banks should now closely monitor current and future market developments. Each institution must analyze whether and how the technology can help or how it could interfere with existing products and processes. A successful implementation will require combining technological expertise with industry understanding and critically analyzing potential application areas.

[2] Bracket = Blockchain based Release of funds that Are Conditionally Key signed and Triggered by signals

3) The over-the-counter market.

Currently, a major business area on which significant attention is focused is investment banking, especially applications in the over-the-counter (OTC) market. Implementation of the blockchain technology within investment banking would entail major changes for large financial institutions and potentially make several market participants obsolete.

Over-the-counter trading constitutes a major business area of investment banking departments and involves the trade of all kinds of financial products without any third parties, such as the exchanges. In the next few years, the global OTC derivatives market is expected to shrink slightly, whereas the OTC trade of traditional products such as shares and fixed-income securities is expected to grow steadily (Figure 15).

The recent financial crises forced regulators in the United States and Europe to increase market transparency and to reduce the risk of market procedures. Measures such as the Dodd-Frank Act in the U.S. tightened regulations and stipulated the involvement of the central clearinghouse counterparty in a bulk share of the trades. On the one hand, the new regulations confer specific benefits for the participants, but on the other hand, they increase the complexity of the OTC market. The value added along the value chain of the OTC trading shifts from the investment banks to the newly implemented third parties. However, reliance on trusted third parties for validation increases the complexity of the system and clients' costs rise owing to an extended number of market participants that have to be rewarded. To comply with the requirements, banks and other financial institutions have to maintain extensive back offices to manage processes and to monitor contracts. Even though the integration of a Central Counterparty Clearing House (CCP) transferred the counterparty credit risk to the intermediary, customers still face liquidity risks, as the settlement time generally amounts to three days maximum ("T+3") and ties up large amounts of capital. Moreover, financial contracts can be subject to fraud or third-party inference.

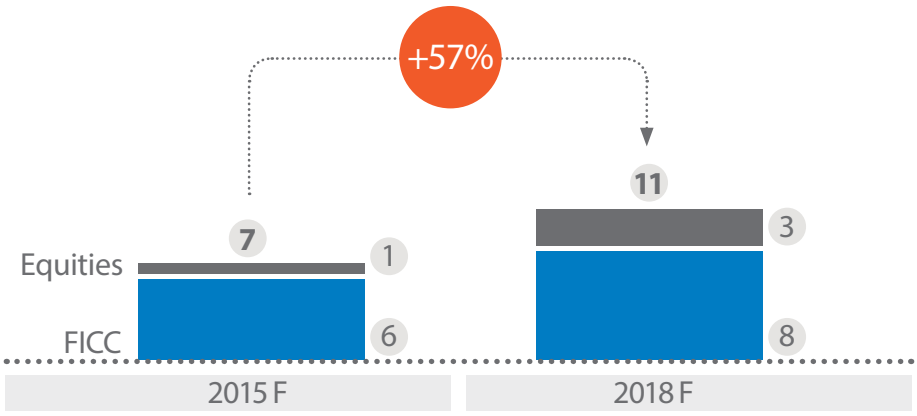


Figure 15: OTC trades of equities and FICCs (2015 F - 2018 F, in bn USD ; source: Illustration adapted from 'Wholesale & Investment Banking Outlook' by Austen, M. et al (2013) / Morgan Stanley and Oliver Wyman

Efficient markets and reshaped business models.

By implementing blockchain technology, market participants could not only eliminate inefficiencies but also reshape business models by exploiting its main potentials, as shown in Figure 16.
Besides simplifying the market, the

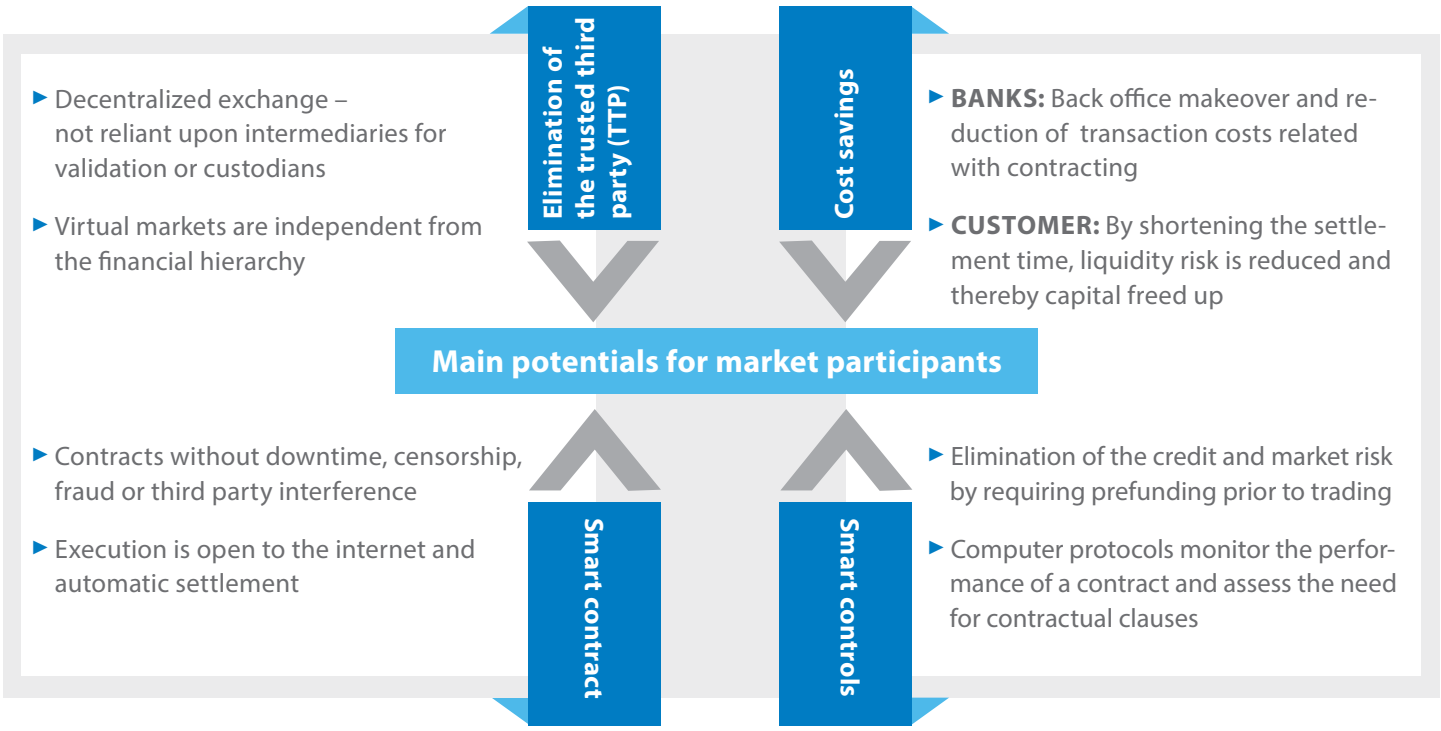


Figure 16: Blockchain potential for OTC market participants; source: Own illustration based on Accenture (2015), H. Shadab (2014) and analysis results

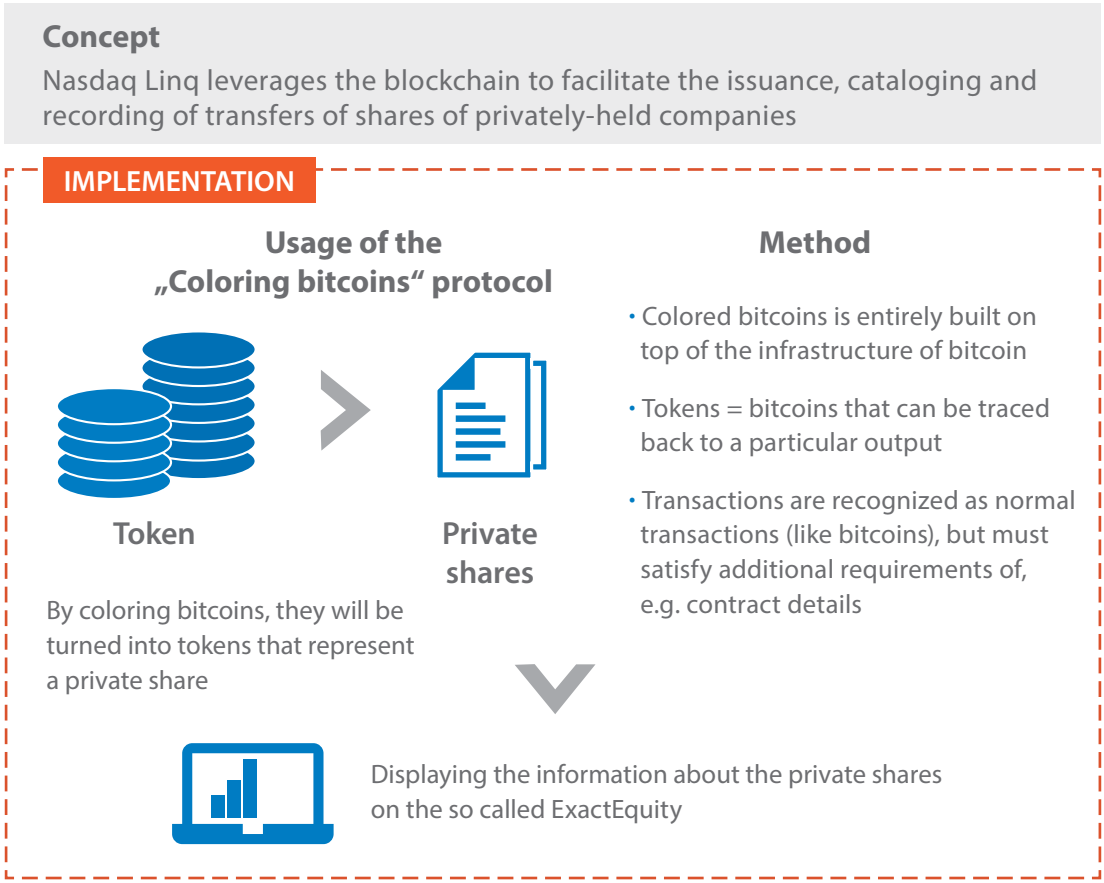


Figure 17: Conception of NASDAQ's Linq; source: Own illustration based on Rizzo, P. / Coindesk (2015), Kaminska, I. (2015), Nasdaq (2015), Rosenfeld (2012), expert interviews (2015) and analysis results

technology enables the implementation of smart contracts in the OTC markets as well as already seen in trade finance. The requirements for a mass implementation and use can be distilled into three broadly defined categories: legal aspects, technological aspects, and institution-specific aspects. The legal aspects present the major hurdle for most participants.

Legal requirements: So far, regulators and other judicial institutions have reacted in a reserved manner concerning the blockchain technology. Fundamental measures in this field include the adjustment of the current legal framework to the distributed ledger framework and the establishment of a legal environment that regulates either the transition from traditional contracts to smart contracts or their coexistence. Besides the basic framework, another major hurdle is the implementation of financial contract specifications as pre-trade agreements and further individual contract conditions.

Technological requirements: Complex market conditions impose high technological requirements. The examples presented in the following discussion are illustrative of the biggest current challenges. First, the implementation of non-digital native assets must be based on standardized terms. Since the introduction of a CCP allows a position netting of a customer, the new technology should also include the ability to operate nettings among different customers. Moreover, market participants want to make use of margin finance and trade assets without possession. Additionally, the speed of confirmation has to be aligned with the speed of the settlement. Both processes should take place simultaneously without one lagging behind the other.

Institution-specific requirements: Each institution faces individual challenges, which require in particular a redesign of the technological architecture. Internal risk, price and capital models currently do not align with the conditions imposed by the implementation of the blockchain technology.

The technology's advantages can already be observed in the form of first-use cases. One example is Nasdaq[12], which implemented the blockchain technology Linq on its stock exchange for private stocks in the field of pre-IPOs, making Linq the first blockchain-based platform for trading and managing private shares. The implementation of the technology simplifies the issuance, cataloguing and recording of shares of privately held companies.

Nasdaq also uses a more advanced bitcoin protocol that enables the coloring of bitcoins (Figure 17). Coloring bitcoins turns them into tokens that represent private shares.

The platform is based on the principle of plain bitcoin transactions that satisfy additional requirements of contract details. This case constitutes an ideal example of how investigators currently operate. Linq can only be accessed by a narrowly selected circle of investors and therefore is classified as a private blockchain. With this use case, Nasdaq addresses especially customers that are open to innovation.

Promising signs – big revenues for FinTechs.

In the field of OTC trading, several FinTechs are investigating protocols that are more appropriate than the early versions of the bitcoin protocol or are exploring the adaptation of the technology in many different areas. At present, Ethereum seems to be the most suitable protocol for future application in the OTC trading market. [13] However, a more open protocol than Bitcoin is exposured to higher risks. Recently, the Ethereum protocol was victim of a hacker attack with a reported damage of around 50 million USD. Besides searching for the most appropriate protocol, the participants are experimenting with various applications on so-called 'private chains'. On private chains, new applications are tested in a delimited area with specific verified participants. Besides following the trend toward private chains, FinTechs are concentrating on a lean enhancement of the current system, for example to use in the record-keeping of shares. These institutions try to redefine the OTC trading market step by step by following a bottom-up approach rather than by seeking a big bang revolution. The landscape is very broad, and within the field of applications, several startups are already going live and operating successfully. Some of the more than 40 promising FinTechs are generating revenues. The urgency for action is growing and it is generally known that all big investment banks, such as Goldman Sachs, UBS, and Credit Suisse, are exploring ways of using blockchain technology in the OTC market, which clearly illustrates the importance of the topic.

UBS acquired the start-up Clearmatics[14] and is currently testing a platform that would allow members to settle their security trades and automate the performance of derivatives and other financial contracts with the decentralized clearing-network technology. Deutsche Bank announced recently that it will undertake similar investigations in the area of fixed-income products. Furthermore, several leading banks have founded research labs to investigate their own use cases and gain a deeper understanding of the subject matter. Especially the big banks seem to concentrate on investment banking and OTC market applications. Besides pursuing their individual aspirations, the world's largest banks have formed the blockchain consortium R3 CEV, in which banks are setting up a hermetically sealed market and ecosystem to test-run products and processes. At the moment, banks seem to be seeking a competitive advantage by building valuable networks, and financial institutions as central clearinghouses are keeping a low profile. Regulators are aware of the blockchain's potential to solve problems within regulation itself and strongly focus on requirements within the OTC market in the course of piloting and implementation. However, restriction by regulation can significantly diminish the dispersal of the technology.

What's next?

The multiple benefits of the blockchain technology are particularly attractive for business models of players within the OTC market. Besides transforming the market infrastructure, the technology could redefine the system of the OTC market and the functionality of financial contracts as a whole by introducing smart contracts. To revolutionize the financial industry, major limitations need to be overcome, and the properties of the protocols have to be further developed and improved to ensure broad use. In the current stage, the potential to fulfil all previously described requirements is questionable. In particular, legally binding statements are missing. In this early stage in the design process, participants should seek to form consortia and work hand in hand with responsible regulators, like the Bank of England, which have partially signaled their openness to the blockchain technology. However, if the participants fail to collaborate with the regulators, restrictions could significantly diminish the dispersion of the technology. Especially large investment banks require favourable regulations for their operations in the area of blockchain technology.

EDC[15] is a Toronto-based startup facilitating the creation and exchange of private shares on a peer-to-peer platform. **Hitfin** [16], a San Francisco-based startup, is building a vertically integrated trading platform that enables market participants to settle complex customized financial contracts without the need for intermediaries and with limited counter-party risks.

Conclusion and outlook.

Distributed ledger and blockchain technology has the potential to be disruptive, as it could completely change processes and systems within financial services. The technology could remove trusted third parties, decrease costs and ultimately increase profits for various players within the industry. However, it is not a one-size-fits-all solution, as potential use cases need to fit to the technology's specific characteristics and requirements. Currently, research is discussing whether public or private blockchain networks are more appropriate for business use cases. Although public blockchains provide high data security and transparency, they are relatively slow if a high number of transactions needs to be processed. Private blockchains instead enable higher transaction speeds and more privacy but often come along with lower security standards. Since both network architectures have their unique advantages and disadvantages, experts predict that private and public blockchains are about to merge in the future. Furthermore, the technology is still in an early stage and has to prove itself in practice. The time horizon for the technology's availability for broad use in financial services is estimated to be 5-10 years.

The technology holds strong potential for many areas of financial services. In the field of payment transactions, it could reshape the current correspondent banking processes and lead to cost savings. In trade finance, the blockchain could induce the urgently needed digital transformation. It improves the segment by providing trust, security, risk mitigation and fast processes at low costs. In over-the-counter markets, the technology has the potential to redesign the market infrastructure and lead to the elimination of obsolete market participants. Moreover, it could enable the automation of contracts and facilitate cost savings through lean back-office processes. The presence of many use cases in these areas substantiates their high potential. Segments such as

the lending business, insurance, real estate and factoring are further promising areas, but research still needs to provide concrete implementation concepts.

The near future will show whether market participants will be able to draw on the disruptive potential of blockchain technology and create successful new business models. One major requirement and challenge while creating and redefining these new business models is to manage the transition phase from old to new processes that incorporate blockchain solutions efficiently. One way of achieving this will surely be the cooperation with regulators in order to establish the legal framework that is urgently needed.

Management summary

Distributed ledger and blockchain are about to cause major business transformations in the financial industry.

Three very promising fields of application are payment transactions, trade finance and the over-the-counter market.

In all of these areas, first projects and deployments can be seen. However, all of them are in a very early stage and have to prove their benefits in practical use. Should blockchain prevail in practice, it has the potential to disrupt traditional business models and make existing players obsolete. This is especially true for trusted third parties.

Besides technical challenges that have yet to be overcome, the lack of a legal framework for the use of blockchain technology is currently a major obstacle.

Many market participants are exploring ways of using blockchain, among them established institutions and start-ups alike.

Banks should now closely monitor current and future market developments.

According to several experts, blockchain technology will reach mass suitability within the next 5 to 10 years.

Notes

1) Accenture. (2015). Distributed Consensus Ledger for Payments. Retrieved January 10, 2016, from https://www.accenture.com/t20151002T010405__w__/us-en/_acnmedia/Accenture/Conversion-Assets/DotCom/Documents/Global/PDF/Dualpub_22/Accenture-Banking-Distributed-consensus-ledgers-payment.pdf

2) Greenwich Associates. (2015): Bitcoin, the Blockchain and Their Impact on Institutional Capital Markets

3) McKinsey & Company. Global Payments 2015: A Healthy Industry Confronts Disruption

4) Ripple. (2015). http://www.ripple.com/.

5) ICC (2014). ICC Trade Register Support. Summary. Global Risks in Trade Finance. Retrieved from: http://www.iccwbo.org/News/Articles/2014/Global-trade-set-to-benefit-from-ICC-report/

6) Calculated on the basis of global trade volume of 16.5 trillion USD in 2015 and the trade finance coverage figure from ICC (80-90%). **Global Trade Volume:** World Trade Organization (WTO).(2016). "Trade growth to remain subdued in 2016 as uncertainties weigh on global demand". Retrieved August 16 2016, from https://www.wto.org/english/news_e/pres16_e/pr768_e.htm

7) Bolero International. (2015). About Us / Solutions / Services / Customers. Retrieved December 5, 2015, from http://www.bolero.net/

8) Global Trade Review (GTR). (2015). Banks develop blockchain platform for trade finance. Retrieved from: http://www.gtreview.com/news/asia/banks-develop-blockchain-based-platform-for-trade-finance/

9) See company websites: http://www.chronicled.com/, https://www.provenance.org/, https://www.skuchain.com/

10) See company website: http://otdocs.com/

11) See company website: http://wavebl.com/

12) See website: http://www.nasdaq.com/press-release/nasdaq-announces-inaugural-clients-for-initial-blockchainenabled-platform-nasdaq-linq-20151027-00986

13) Source: http://www.zeit.de/digital/internet/2016-06/the-dao-blockchain-ether-hack.

14) See website: http://www.clearmatics.com/

15) See website: http://equibit.org/

16) See website: http://www.hitfin.com/#settlement

Illustrations

Accenture. (2015). Distributed Consensus Ledger for Payments. Retrieved January 10, 2016, from https://www.accenture.com/t20151002T010405__w__/us-en/_acnmedia/Accenture/Conversion-Assets/DotCom/Documents/Global/PDF/Dualpub_22/Accenture-Banking-Distributed-consensus-ledgers-payment.pdf

A.T. Kearney (2013); Winning the Growth Challenge in Payments

Austen, M., et al, (2013, April 11). Wholesale & Investment Banking Outlook Global Banking Fractures: The Implications. Retrieved January 10, 2016, from http://www.oliverwyman.de/content/dam/oliver-wyman/global/en/files/archive/2013/Outlook_for_Wholesale_and_Investment_Banking_2013.pdf

Bitcoin. (2015). Block hashing algorithm. Retrieved January 10, 2016, from https://en.bitcoin.it/wiki/Block_hashing_algorithm

Bolero International. (2015). About Us / Solutions / Services / Customers. Retrieved December 5, 2015, from http://www.bolero.net/

Diaz, M.-C. (2012). BPO - a corporate perspect on supply chain finance (Presentation at Eurofinance Monaco). SWIFT, Monaco.

ECB. (2015). Virtual currency schemes – a further analysis. Retrieved January 10, 2016, from https://www.ecb.europa.eu/pub/pdf/other/virtualcurrencyschemesen.pdf

European Payments Council. (2015). Ripple: an Internet Protocol for Inter-bank Payments.

Everledger. (2014). Insurance fraud is a global problem. Retrieved November 23, 2015, from http://www.everledger.io/

Goldman Sachs. (2014). All about Bitcoin. Retrieved January 10, 2016, from http://www.paymentlawadvisor.com/files/2014/01/GoldmanSachs-Bit-Coin.pdf

ICC International Chamber of Commerce. (2014). Bank Payment Obligation (BPO) Frequently Asked Questions for Banks. Paris.

Kaminska, I. (2015). Blockchain promises back-office ledger revolution . Financial Times.

Nakamoto, S. (2009). Bitcoin: A Peer-to-Peer Electronic Cash System. Retrieved January 10, 2016, from https://bitcoin.org/bitcoin.pdf

NASDAQ OMX Newsroom - Press Release. (2015, May 11). Retrieved January 4, 2016, from http://www.nasdaqomx.com/newsroom/pressreleases/pressrelease?messageId=1361706

Ripple. (2015). http://www.ripple.com/.

Rizzo, P. (2015, November 21). Inside Linq, Nasdaq's Private Markets Blockchain Project. Retrieved January 10, 2016, from http://www.coindesk.com/hands-on-with-linq-nasdaqs-private-markets-blockchain-project/

Rosenfeld, M. (2012, December 4). Overview of Colored Coins. Retrieved January 10, 2016, from https://bitcoil.co.il/BitcoinX.pdf

Royal Bank of Scotland, Capgemini. (2015). World Payments Report 2015.

Santander. (2015). He Fintech 2.0 Paper: Rebooting financial services. Retrieved January 10, 2016, from http://santanderinnoventures.com/wp-content/uploads/2015/06/The-Fintech-2-0-Paper.pdf

Shadab, H. B. (2014). Regulating Bitcoin and Block Chain Derivatives. Retrieved January 10, 2016, from http://www.cftc.gov/idc/groups/public/@aboutcftc/documents/file/gmac_100914_bitcoin.pdf

skuchain. (2015). Connect to the Commerce Cloud. Retrieved November 22, 2015, from http://www.skuchain.com/

SWIFT. (2015). Market adoption of BPO. Retrieved November 28, 2015, from https://www.tradefinance.training/library/files/BPO%20Market%20Adoption%20Aug2015.pdf

US Department of Treasury (2007). Fundamentals of the funds transfer process. Washington, D.C.

VISA (2006). The Inefficiencies of Cross Boarder Payments, Retrieved December 20, http://euro.ecom.cmu.edu/resources/elibrary/epay/crossborder.pdf.

Wolf, F. O. (2013, October). Die Bank Payment Obligation (BPO) im Außenhandel. Exportmanager-Online.

About the authors

Dr. Eric G. Krause

is a Partner with Infosys Consulting, the global Management Consulting Firm of Infosys. Eric is responsible for Financial Services in Germany. He holds a doctoral degree from Universität St. Gallen (HSG), CH.

Jun.- Prof. Dr. Vivek K. Velamuri

is the Schumpeter Junior Professor for Entrepreneurship and Technology Transfer at the HHL Leipzig Graduate School of Management, Germany. He holds a doctoral degree from Friedrich Alexander University of Erlangen-Nuremberg, Germany.

Tobias Burghardt

is a full-time Master in Management student at HHL Leipzig Graduate School of Management with the focus on finance, accounting and strategy. He did his Bachelor of Arts in Business Administration at the University of Applied Sciences in Zwickau. In the course of his studies he absolved an exchange semester at the University of Borås and a term abroad at the Indian Institute of Management in Bangalore.

Tobias Burghardt has experience in the fields of investment banking, strategy consulting, restructuring and international project management.

Denny Nack

is a full-time Master in Management student at HHL Leipzig Graduate School of Management. He holds a Bachelor of Science degree in Business & Economics from the University of Technology Dresden. Furthermore, he completed exchange semesters at Shanghai Jiao Tong University and The University of Wolverhampton. Throughout his studies, he majored in the fields of strategy, supply chain management and IT.

He gained working experience in strategy consulting, IT consulting as well as auditing with an emphasis on the automotive industry.

Moritz Schmidt

is a full-time Master in Management student of the HHL Leipzig Graduate School of Management and has conducted two semesters in the Master in Finance program at EADA. Moreover, he holds a Bachelor degree of the Cooperative State University Mannheim with a major in Banking and Finance.

He conducted his full-time study program in combination with a vocational training as a bank management assistant for Deutsche Bank. During his master studies, he gained experiences in the consultancy sector for financial services.

Tobias - Micha Treder

is a full-time Master in Management student at HHL Leipzig Graduate School of Management with the focus on finance, accounting and strategy. After his bachelor studies he gained experience as a financial controller in vehicle financing and leasing at Société Générale Group in Hamburg. Moreover he worked in project management and business development within automotive industry in Stuttgart.

He holds a B.A. in Business Administration from HSBA Hamburg School of Business Administration and is a management assistant in wholesale and foreign trade (IHK).

About Infosys Consulting

Infosys Consulting is a wholly owned subsidiary of Infosys (NYSE: INFY), a global leader in technology services and consulting, with a team of 190,000+ innovators serving clients in more than 50 countries.

Infosys Consulting forms the global management consulting arm of Infosys. A pioneer in breaking down the barriers between strategy and execution, Infosys Consulting delivers superior business value to its clients by advising them on strategy and process optimization as well as IT-enabled transformation.

Please visit us at **www.infosys.com/consulting** to find out more about how we go beyond the expected to deliver the exceptional.

About HHL Leipzig Graduate School of Management

HHL Leipzig Graduate School of Management is a university-level institution and ranks amongst the leading international business schools. The goal of the oldest business school in German-speaking Europe is to educate effective, responsible and entrepreneurially-minded leaders. HHL stands out for its excellent teaching, its clear research focus, its effective knowledge transfer into practice as well as its outstanding student services. The courses of study include full and part-time Master in Management as well as MBA programs, a Doctoral program and Executive Education. According to the Financial Times, HHL ranks first in Germany and fifth globally for its entrepreneurship focus within the M.Sc. and EMBA programs. HHL is accredited by AACSB International.

www.hhl.de

For more information, contact consulting@infosys.com

Infosys® | CONSULTING

August 2016

Stay Connected