BLOCKCHAIN IN TRADE FINANCE AND SUPPLY CHAIN

a thematic report prepared by

THE EUROPEAN UNION BLOCKCHAIN OBSERVATORY AND FORUM

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About this report

The European Union Blockchain Observatory & Forum has set as one of its objectives the analysis of and reporting on a wide range of important blockchain themes, driven by the priorities of the European Commission and based on input from its Working Groups and other stakeholders. As part of this it will publish a series of thematic reports on selected blockchain-related topics. The objective of these thematic reports is to provide a concise, easily readable overview and exploration of each theme suitable for the general public. The input of a number of different stakeholders and sources is considered for each report. For this paper, these include:

- Members of the Observatory & Forum's Working Groups as well as the Obeservatory's Supply Chain Sub-Working Group (please see next page).
- Input from participants at the "Supply Chain and Traceability" workshop held in Brussels on 19 February, 2019.
- Input from the Secretariat of the EU Blockchain Observatory & Forum (which includes members of the DG CONNECT of the European Commission and members of ConsenSys).

CREDITS

This report has been produced by ConsenSys AG on behalf of the European Union Blockchain Observatory & Forum.

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DISCLAIMER

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NOTE

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Executive summary

The supply chain and trade finance industries face serious challenges.

Globalisation has made **supply chains significantly more complex**, involving multiple players from around the world and a great deal of coordination among large numbers of stakeholders who **do not necessarily trust each other**. While this has driven up operating costs, increased regulation is driving up the cost of regulatory compliance. Many processes are outdated, often paper-based, and supply chains suffer from a lack of transparency due to data not being readily available.

In this paper we examine how blockchain technology might provide a means to address many of these issues. Blockchain can be used **to break existing information silos** and interconnect data sources and participants. It can be used to **share trusted data** among large numbers of actors in a supply chain, and, via smart contracts, can support the **automation of transactions**. It can also be used to support **innovative financial services**, among other things by reducing the need for intermediaries.

Blockchain-based platforms can help **combat fraud, prove quality and provenance** and **manage complexity**. Transparent, reliable and auditable data can shine a "big light" along the chain, helping to **root out counterfeits** and **identify bottlenecks**. Auditable supply chains with real- or near-real-time data can also make it easier to **trace faulty materials, ingredients or products** to their source, increasing the timeliness and accuracy of recalls and other public safety measures. Auditability is also a potent tool in **anti-counterfeiting and intellectual property (IP) protection**. Blockchain can help **streamline compliance** procedures and introduce massive efficiencies to supply chain coordination, with potentially significant savings. Blockchain-based platforms could **simplify border procedures** and provide customs agents as well as regulators with better, more efficient tools with which to monitor and engage with supply chains.

In **trade finance**, blockchain could be a useful tool to **streamline today's often manual and costly processes**. By catalysing digitisation, blockchain-based platforms could increase the speed of transactions as well as their security, facilitating financial flows between counterparties. Blockchain-based digital identities could also help streamline know-your-customer and other compliance requirements.

EXECUTIVE SUMMARY

Blockchain may catalyse innovation in trade finance. **Automatic payments** through smart contracts could help ease working capital bottlenecks, while far greater auditability of transactions could streamline **reporting, accounting and other processes**, as well as provide better intelligence as to the state of markets. This could in turn lead to new kinds of financial instruments for trade finance.

Getting there will require solving a number of challenges. Stakeholders must figure out **how to handle the data "on ramp"** as blockchain can do nothing against the introduction of erroneous data, whether by accident or design. Blockchain faces technical issues of **scalability and interoperability** that need to be overcome. Many **legal and regulatory** questions remain unanswered, particularly around the legal status of blockchain-based transactions. The data transparency afforded by blockchain platforms, while useful for managing and securing supply chains, can **risk exposing confidential information** to competitors. Since blockchain-based platforms are often best deployed in consortia, they presuppose "coopetition" of some form among stakeholders. But **cooperating with competitors** also requires new mindsets.

Despite these hurdles, we think the **future is bright** for blockchain in supply chains To help get there, we recommend that European policy makers continue their strong support of blockchain research and development, including **focusing on supply-chain relevant questions** around interoperability among blockchains and between blockchains and other technologies. Governments can also **support dialogue** between supply chain and trade finance stakeholders, including facilitating and potentially joining consortia, as well as use blockchain themselves in order to better understand its potential. We also believe they should **continue to clarify** the aforementioned legal and regulatory issues around blockchain, as well as to **facilitate standards-setting**, both as it pertains to blockchain and for supply chain use cases.

For companies, our message is clear: **learn about blockchain** and its potential. This requires an understanding of both the technology and its uses, including new forms of governance. Many companies may find it difficult to switch to the "coopetition" mindset that underlies many blockchain consortia. There are **certainly risks involved** in new ways of working, but we think the potential benefits, not just in increasing efficiency and reducing costs, but also in **better catering to customer needs**, may outweigh them. It is certainly worth a look.

Introduction

GLOBAL TRADE: A SECTOR IN SEARCH OF INNOVATION

Both the supply chain and trade finance industries face daunting challenges.

Globalisation has made supply chains significantly more complex, involving multiple players from around the world and a great deal of coordination. This increases the cost of operating these global networks, with goods and services channelled across emerging and advanced economies. According to the Global Alliance for Trade Facilitation, the cost of operating supply chains makes up two-thirds of the final cost of traded goods, while 7% of the global value of trade is absorbed in documentation costs alone.[1]

At the same time, companies are facing growing regulatory and compliance costs, and are under increased pressure to react quickly to supply chain issues – like faulty products or materials – for safety and public health reasons. End users are also increasingly demanding transparency with regard to the ingredients and materials of the products they use. Brands and suppliers can only meet this demand if they themselves have transparent supply chains.

Companies need technological innovation to make their supply chains more cost-effective, resilient and responsive to potential market disruptions. Between the late 1980s and early 2000s, the emergence of global value chains – which were to become the main vehicle of international trade – was enabled in large part by advances in information technology that drastically reduced the cost of coordinating production stages carried out in different countries.[2]

Today, international trade is facing a global slowdown and industries have signalled several critical challenges to global value chains, including: (i) a lack of transparency due to inconsistent or not readily available data; (ii) a high proportion of paperwork; (iii) a lack of interoperability; and (iv)

1 See EM Compass Note 45, International Finance Corporation, September 2017.

2 Improved complexity (GVC length) is higher than the increased transaction cost. This means that (i) the total accumulated trade cost along the GVC is bounded by the GVC performance in terms of efficiency but also that, (ii) for a given structure of efficiency gains, the length of the GVC is negatively correlated to trade costs. WTO, 2017. Accumulating Trade Costs and Competitiveness in Global Value Chains. https://www.wto.org/english/res_e/reser_e/ersd201702_e.pdf

limited information on the product's journey. in the chain.[3]

The trade finance industry, which focuses on injecting liquidity and mitigating credit risk in both domestic and international trade transactions, faces similar issues. Trade finance usually involves a seller or exporter of goods and services, a buying organisation or importer and various intermediaries such as banks, financial institutions and service providers. Sellers and buyers are constantly looking to improve their working capital and cash flow, while reducing the risk of supply chain disruptions.

Unfortunately, the trade finance sector today is inefficient and not scalable based on the prevailing underlying technology. The systems currently used by banks and their corporate, SME and other trade finance clients to manage trade and working capital finance are siloed and highly manual, resulting in a lack of visibility and high overhead costs. Here too, stakeholders have been looking for innovative answers.

BLOCKCHAIN: A KEY COMPONENT OF THE SOLUTION?

While digitisation of supply chains is already underway with technologies such as cloud computing, artificial intelligence and the Internet of Things (IoT), blockchain appears to be the missing element in the mix to enable all these emerging technologies to work together securely and efficiently.

Blockchain can be used to break down existing information silos and interconnect data sources and participants, providing a secure base for all of them to develop. Larger economies of scale support IoT deployments, while larger and more reliable data sets (from IoT and the connected supply chain updated in real time) provide the "big data" to allow AI to make smart recommendations and for machine learning to improve its algorithms.

Blockchain can also be used to provide innovative financial services, as well as platforms that offer contracting parties the ability to verify that every link in a supply chain network is authentic, without the need of an intermediary such as a clearing house or banking institution.

Among the technology's interesting characteristics in supply chain and trade finance settings are:

3 Lierow, Michael, Cornelius Herzog, and Philipp Oest. 2017. "Block-chain: The Backbone of Digital Supply Chains." Oliver Wyman.

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- **Decentralisation and open source.** Blockchain-based platforms tend to be decentralised to some or a great extent. This allows stakeholders to build and participate in platforms that are not controlled by any one entity but are rather shared. Since most blockchain protocols are open source, stakeholders are not locked into to a vendor's offering and can easily examine and vet the code.
- **Immutability and trust in data.** Blockchain-based systems can provide high assurance that data entered into the system remains viable: that it either cannot be tampered with or that attempts to manipulate data are easily recognised. This can greatly increase the trust in that data, but requires that the data itself is correct at the time of its entry into the chain.
- **Uniqueness and trust in digital data.** Blockchain can be used to create unique instances of data, including digital documents, that cannot be subsequently altered or replicated. This can greatly facilitate the use of electronic transactions by increasing trust in the provenance and validity of their contents.
- **Transparency and auditability of data.** With blockchain it is possible to build large-scale platforms with multiple stakeholders in which it is relatively easy to see who has done what with the data along the chain, providing high levels of transparency and auditability.
- **Self-sovereignty and privacy/selective disclosure of data.** Depending on the blockchain technology used and how they are designed, blockchain-based platforms can also offer a high degree of privacy and control over data despite their open nature. This can allow stakeholders to keep proprietary data private while selectively disclosing parts of it as needed. Newer technologies like zero-knowledge proofs can also allow stakeholders to prove claims without divulging the underlying information. These characteristics can be very useful in heterogeneous and highly competitive environments like those found in supply chains, though they are not without their risks.
- **Automation and efficiency.** Through smart contract technology, it is possible to automate many of the processes in blockchain-based platforms, including coding in complex business logic and transactions that can self-execute based on conditions. Such capabilities could increase efficiencies in many areas of a supply chain.

Another reason why blockchain is interesting for the supply chain and trade finance communities is that it is a technology well-suited to use cases involving many different stakeholders. Typical supply chains require

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cooperation and coordination among a wide group of actors, including:

- Producers of raw materials
- Manufacturers
- Shipping and transport companies
- Brands
- Government authorities (in particular customs officials and regulators)
- Banks and insurance companies
- Fintechs (non-banks) looking to provide services
- End consumers

In the next two sections we look at these potential benefits in more detail.

How blockchain can help improve supply chains

In this section we take a look at some of the problems specific to the execution of supply chains to which blockchain technology might be employed.

For the sake of illustration, we break down supply chains into three main sections – upstream, production and downstream. In each of these we can identify a number of areas in which there is a need for reliable data among a diverse set of actors who do not necessarily trust each other. These challenges often have to do with either a) combating corrupt practices, b) proving good practice/ authenticity or c) managing complexity.

CHALLENGES ALONG THE SUPPLY CHAIN

1. Upstream challenges

While a slight oversimplification, we can associate the upstream part of the supply with the gathering of raw materials, whether produce, livestock or fish for food supply chains, metals or minerals for manufacturing or any other basic material that is needed to create some finished product.

There are many different challenges in the upstream component.

One is to identify and so avoid the use of raw materials "harvested" via unsustainable or immoral practices like child and slave labour, or through the exploitation of small farmers or mine workers or via other undesirable means.

Another is to ensure that materials really are what they purport to be. Here the challenge is to combat dishonest actors by attaching reliable data about provenance and authenticity to a material and track it along the chain to ensure it has not been substituted. This task can be quite complex. In cases where you have a large number of sources – hundreds of small farmers supplying palm oil, say, or fleets of independent fisherman supplying tuna – it can be challenging to gather and keep track of quality information even if all of them are honest.

2. Production challenges

At some point along the chain raw materials are converted into finished products, either at a single or more often along a chain of production facilities (in which a finished product from one facility becomes a component used to manufacture a product in another).

Here too there are many challenges.

Those purchasing products higher up along the chain will want to be sure the producer is really using the raw materials it says it is using, or that a product comes from a facility that is safe and whose methods and labour practices are compliant with industry standards and regulations.

Those production facilities meeting these standards can benefit by being able to prove that they are compliant and their products are authentic. Doing so, however, requires a means of identifying the products from their facility as they travel along the chain.

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Manufacturers typically face daunting coordination and logistics challenges, for example coordinating the delivery of raw materials so as to avoid bottlenecks or overstocking.

3. Downstream challenges

For our purposes, the downstream part of the supply chain is where components or finished products are transported to their points of use or sale and so make their way to end users, whether companies or consumers. Downstream can also include the "aftermarket", where finished products are re-sold or recycled.

Transport is one of the major challenges in downstream supply chains. Here it is often very important to ensure and prove that items have been handled correctly during shipment: food and medicines often need to be kept at certain temperatures, for instance, or items need to arrive within a certain time frame. It is also important to ensure that items are not stolen and/or replaced by counterfeits.

Transport and logistics is also immensely complex. Shipment over long distances and across multiple jurisdictions requires coordination among different companies and authorities. Proof of provenance and authenticity is also becoming increasingly important at the retail and aftermarket stages. Consumers want to be sure of the origin and quality of the things they are buying. Buyers and sellers in aftermarkets, particularly for luxury or very expensive items, have a strong interest in being able to prove provenance and authenticity too.

Last but by no means least, in an age of climate crisis facilitating the recycling and reuse of products is becoming a necessity. Here too a major challenge is simply in identifying products that can be recycled, and coordinating the efforts to do so.

ADDRESSING SUPPLY CHAIN CHALLENGES WITH BLOCKCHAIN

Blockchain can be used to address the above-mentioned supply chain challenges in different ways.

With transparent, reliable and auditable data along the supply chain it can be much easier to track items as they move along the chain as well as provide a history of what transpired during that journey, either with the item itself or its surroundings. Shining that kind of "big light" along the chain can in turn make it harder for corrupt actors to cheat, either by introducing counterfeit goods or using sub-standard processes or working methods. It can also make it easier to ferret out honest but incompetent actors along the chain by more easily identifying problem areas or tracing defective products and materials back to their source.

One area where this might be of particular use is in counterfeiting along the supply chain by improving the administration and enforcement of IP rights across multiple jurisdictions. Blockchain for registered and unregistered rights could arguably be used to provide proof of creation, existence, ownership and/or first use; to register IP rights; to facilitate the administration and management of IP rights on a global scale, thereby potentially contributing to the emergence of "global IP chains"; and to enforce IP rights and fight counterfeits in a more efficient way.
Proof of the provenance, history, handling and

destination of products and materials in the supply chain, if accessible to and acceptable for the authorities, can also greatly simplify regulatory compliance procedures, with potentially massive efficiency gains and cost savings for all involved. These same properties could help greatly streamline, automate and improve the effectiveness of customs and excise procedures – provided the authorities are also on the platform. Blockchain could also ease the document flow and the interactions between parties of an international shipment.

All of this could be a boon to the actors in the chain. The intrinsic characteristics of the technology also make it a potentially interesting tool to help implement the WTO Trade Facilitation Agreement (TFA) and to facilitate business-to-government (B2G) and government-to-government (G2G) processes at the national level.[1]

Blockchain and smart contracts could help administer border procedures and national single windows (a single point of entry through which trade stakeholders can submit documentation and other information to complete customs procedures) in a more efficient, transparent and secure manner, and improve the accuracy of trade data. The real challenge will be to make cross-border G2G processes more efficient.

This will not only require settling interoperability issues at a technical level – an issue on which the blockchain community is working actively – it will also require standardisation and political will to create a regulatory framework that is conducive to paperless trade.

1 Emmanuelle Ganne, Can Blockchain Revolutionize Trade?, World Trade Organization, 2018.

SUPPORTING SUPPLY CHAIN INNOVATION WITH BLOCKCHAIN

Blockchain-based platforms have the potential to do more than just solve supply chain problems. They can also support many of the improvements and innovations that stakeholders would like to see, as well as enable new business models.

For example, blockchain-based platforms can contribute to a far more detailed and reliable aggregate view of what is happening along a supply chain, helping managers to spot bottlenecks and so locate areas where efficiencies can be introduced. A better understanding of the state of their supply chains will help managers improve planning and coordination, and could assist in finding new channels or approaches to streamlining the chain. Smart contracts in turn could be used to automate many logistics and payments processes in ways that were not possible before, streamlining delivery versus payment or opening up new avenues for working capital management.

Blockchain-based platforms could support more detailed, accurate and trustworthy analysis of the lifecycle of a product. This too could open up new business models. For example, we may find new types of markets for products that don't meet the highest standards, but are demonstrably "good enough" to be used in secondary contexts. As consumers increasingly demand transparency into what they are buying, the ability to publicly provide lifecycle data about products, and so prove provenance and quality, will become a competitive advantage. Having detailed lifecycle data available for individual

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products can also support the circular economy by making it easier to track and identify items, or their component parts, for reuse or recycling.

That could mean big business. Research by the OECD indicates that "green trade" is rising in political and economic importance, "with a global market of $1 trillion a year for environmental goods and services close".[2] Sustainability Consortium's 2016 Impact Report found that the majority of consumer goods manufacturers lack visibility into the sustainability performance of their supply chains.

The "greening" of global supply chains, however, requires traceability and transparency. The former is necessary to track hazardous products and materials, allocate responsibilities and monitor environmental compliance. The latter is a precondition for achieving credibility, legitimacy and fairness, and to avoid "green-washing" or shifting polluting activities to developing countries".

2 The OECD defines environmental goods as "activities which produce goods and services to measure, prevent, limit, or minimize or correct environmental damage to water, air and soil, as well as problems related to waste, noise and ecosystems». See: Sugathan, Mahesh. 2004. "Environmental Goods and Services Negotiations: Challenges and Opportunities". WTO Workshop on Environmental Goods - Para 31 (iii) of the Doha Development Agenda, International Centre for Trade and Sustainable Development, 11 October, 2004.

How blockchain can help improve trade finance

THE IMPORTANCE OF TRADE FINANCE AND THE CHALLENGES IT FACES

Trade finance, a market worth USD 10 trillion in 2017,[1] is a necessary requirement for global trade. While some international trade transactions are paid for in advance, the vast majority have to be financed in some way. This is, among other things, due to a lack of trust: buyers want to be sure their purchases have arrived in good condition before they pay for them. Sellers, on the other hand, would like to be sure buyers can pay. While waiting for payment, sellers in particular find their capital tied up. Various intermediaries including banks and insurance companies have arisen to deal with these imbalances.

Traditional trade and supply chain finance mechanisms include letters of credit or factoring. In some jurisdictions, including Europe, many are turning to open account trading, in which exporters sell "on consignment" to importers. This can eliminate the need for intermediaries between the parties, but it also puts all the risk on the seller. In many cases sellers will look to finance or insure that risk in some way.

Without trade finance and insurance, global trade would likely ground to a halt. Yet the industry has remained relatively static, even slower to digitise than supply chains. Processes remain largely paper-based and above all complex. GTReview estimates that a trade finance deal for a single commodities cargo shipment by sea may require up to 36 original documents and 240 copies from as many as 27 parties.[2] It can often take weeks, if not months, to complete. A Boston Consulting Group study found that there were generally more than 20 parties involved in a single trade finance transaction and some 10 to 20 documents with approximately 5,000 data field interactions. According to Deloitte, trade finance today is facing the following pain points:[3]

- **Manual contract creation.** The import bank manually reviews the financial agreement provided by the importer and sends financials to the correspondent bank.
- **Invoice factoring.** Exporters use invoices to achieve short-term financing from multiple banks, adding additional risk in the event the delivery of goods fails.
- **Delayed timeline.** The shipment of goods is delayed due to multiple checks by intermediaries and numerous communication points.
- **Manual AML review.** The export bank must manually conduct AML checks using the financials provided by the import bank.
- **Multiple platforms.** Since each party across countries operates on different platforms, miscommunication is common and the propensity for fraud is high.
- **Duplicative bills of lading.** Bills of lading are financed multiple times due to the inability of banks to verify their authenticity.
- **Multiple versions of the truth.** As financials

1 How Blockchain Can Reshape Trade Finance, Deloitte.

2 komgo unwrapped: Financing commodity trade on blockchain, GTR Global Trade Review, 21 January, 2019.

3 How Blockchain Can Reshape Trade Finance, Deloitte.

are sent from one entity to another, significant version control challenges exist as changes are made.
- **Delayed payment.** Multiple intermediaries must verify that funds have been delivered to the importer as agreed prior to the disbursement of funds to the exporting bank.

There have been attempts to deal with these issues through digitisation in the past. Platforms like essDocs and Bolero have focused on digitising trade finance processes. But this generally involves digital versions of paper documents, not true digital transactions. In addition to complexity issues, banks and other intermediaries have historically not had great incentives to make large investments in innovation.

Thankfully, this is changing. Faced with increased regulation, dwindling margins and competition from Fintech firms, banks and insurance companies involved in trade finance have lately been looking much more seriously at ways to digitise their processes and increase efficiencies.

BLOCKCHAIN'S POTENTIAL IN TRADE FINANCE

Many people in the trade finance industry see blockchain as a useful tool to streamline processes. One way is simply by catalysing digitisation by offering a means of enhancing trust in digital documents and transactions. This in turn could increase the speed of such transactions as well as their security, facilitating financial flows between counterparties. Blockchain-based digital identities could also help streamline know-your-customer and other compliance requirements.

Blockchain could also help catalyse innovation in the trade finance sphere. It could provide enhanced transparency into supply chains and stakeholders, potentially enabling new kinds of financial instruments. It can facilitate automatic payments through smart contracts, as well as provide far greater auditability of transactions. This could in turn streamline reporting, accounting and other processes, as well as lead to better intelligence as to the state of markets. This could be of interest both to the actors along the supply chain as well as authorities.

Again according to Deloitte,[4] potential benefits include:

- **Real-time review.** Financial documents linked and accessible through blockchain are reviewed and approved in real time, reducing the time it takes to initiate shipment.
- **Transparent factoring.** Invoices accessed on blockchain provide a real-time and transparent view into subsequent short-term financing.
- **Disintermediation.** Banks facilitating trade finance through blockchain do not require a trusted intermediary to assume risk, eliminating the need for correspondent banks.
- **Reduced counterparty risk.** Bills of lading are tracked through blockchain, eliminating the potential for double spending.
- **Decentralised contract execution.** As contract terms are met, status is updated on the blockchain in real time, reducing the

4 How Blockchain Can Reshape Trade Finance, Deloitte.

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time and headcount required to monitor the delivery of goods.

- **Proof of ownership.** The title available within blockchain provides transparency into the location and ownership of the goods.
- **Automated settlement and reduced transaction fees.** Contract terms executed via smart contracts eliminate the need for correspondent banks and additional transaction fees.
- **Regulatory transparency.** Regulators are provided with a real-time view of essential documents to assist in enforcement and AML activities.

Hurdles to realising blockchain's potential in supply chain and trade finance

For all its potential, there are still a number of hurdles to be overcome and risks to manage when it comes to successfully deploying blockchain technology in supply chains and trade finance contexts.

First and foremost is managing the data "on-ramp". While blockchain is an excellent way to exchange trusted data among large groups of heterogeneous stakeholders, it can do nothing against the introduction of erroneous or intentionally corrupt data. That has to be managed off chain. If that cannot be done, then not only is there the risk inherent in bad data on the chain, but the detrimental effects of that data could be magnified by the de facto "seal of approval" granted by its existence on a trusted platform.

For that reason blockchain is not likely to be of use on its own, but rather as part of a suite of technologies used in supply chain solutions.

There is much potential in integrating blockchain with the Internet of Things (IoT) devices, for example. To ensure quality data gets on the chain, many people are looking to integrate sensors into blockchain-based solutions. This can also help increase the volume of data that is collected, and do so in a more efficient and cost-effective way than with manual entry. Other devices, for example GPS trackers or RFID tags, could also aid in ensuring accurate and timely information about the location and condition of items. Many are also looking to use blockchains in conjunction with various forms of artificial intelligence (AI) to help manage data flows, analyse data to look for patterns as well as to ensure data quality. While there are potential benefits here, this also represents a hurdle, as means need to be found to integrate these technologies.

Blockchain technology itself is also still quite new, and there are well-known issues around scalability and interoperability that will need to be addressed before blockchain-based platforms can realise their full potential in global platforms.[1] Security and privacy of blockchains is also an ongoing issue. Some important ancillary technologies, like zero-knowledge proofs, are newer still, and as yet unproven. Unlocking their potential will take time.

For large-scale blockchain-based supply chains to be successful, there are any number of legal, regulatory and organisational hurdles to overcome. The most important of these in the supply chain and trade finance context are issues around recognising the legal status of blockchain transactions.

Large-scale platforms imply mass adoption. That likely won't happen without global standards either. That in turn will also require buy-in and participation from regulatory and other authorities, like customs and excise, to be effective.

1 Scalability, interoperability and sustainability of blockchains, European Union Blockchain Observatory & Forum, 6 March 2019.

How blockchain can be used in specific industries

In this section we look at some of the supply chain problems faced by specific industries and sectors, and show how blockchain might be used to solve them. As many problems are common to all industries, we have tried to use different sectors to illustrate different aspects of supply chain challenges. For more detail, you will find a list of representative projects in the appendix.

1. Oil & Gas: Performance-based contracts[1]

Thanks to its size, complexity and fundamental importance to all parts of the economy, the oil & gas sector provides a good example of how blockchain can be used to meet challenges all across the chain. These challenges are legion. Exploration and extraction are very expensive, often dangerous undertakings that can involve coordination among 30 to 40 different companies at a time. Crude oil and gas then need to be shipped, via tankers or pipelines, to refineries, another complex process involving numerous suppliers. Refined products like gasoline, natural gas, jet fuel, diesel, asphalt, etc. need to be transported to their distribution centres and finally into the hands of end customers, whether commercial or consumer.

Blockchain could be employed in many different ways along these chains. Blockchain-based identities, signatures and documents could be used to document the identities and credentials of workers either on wells, in refineries or when inspecting pipelines. These workers are often responsible for recording important data, potentially under difficult conditions. This can be problematic: field capture error rates in the industry are estimated to run at 25–30%. While blockchain can not reduce error rates, by providing a transparent data store, including information on who entered data and when, it can make it easier to spot outliers and so "sanitise" bad data after the fact. Having clear, reliable records of who did what and when, coupled with evidence of the quality of the work, can also greatly simplify invoicing by allowing for performance-based contracts. In such a scenario, the blockchain could be used to store verified and verifiable as well as immutable attestations that they have successfully completed a job. Smart contracts, also on the blockchain, could then trigger automatic payments based on these attestations. This could dramatically speed up the time it takes for payments to be made, to the benefit of contractors. Blockchain-based attestations of work could also potentially simplify dispute reconciliation.

2. Food: Trust in origin and quality

The quality of the food we eat is of great concern to all of us, and ensuring that quality along what have become global, complex supply chains is one of the largest challenges of the food and beverage industries.

On the one hand, food companies need to adhere to a wide set of regulations or standards, for example standards for organic food or fair trade labelling, or regulations involving environmental sustainability or supplier inclusion mandates. To ensure safety, companies need to be able to quickly identify issues in the supply chain and quickly trace outbreaks to their source. For their

1 This section is heavily indebted to a series of blog posts by Ondiflo. See A History of Disruption in the Energy Industry and subsequent articles.

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part, consumers are becoming increasingly interested in where their food comes from and how it has been produced and transported. Being able to provide trustworthy information can help secure customer loyalty and be a competitive advantage.

Blockchain-based platforms could be used to implement robust "track and trace" capabilities along food supply chains, enabling the proverbial tracing "from farm to fork". Such platforms would allow stakeholders to more reliably identify and document the source of an ingredient as well as keep a record of its movements and transformations along the chain, including environmental information (was the item kept at safe temperatures throughout the journey, for example). Such data could provide extremely useful audit trails in cases of contamination, and can also add efficiency to safety inspections by more readily identifying red flags. At the same time, food brands could use reliable information on the provenance of their ingredients to increase the appeal of their products, and authorities could use it to add trust to food labels, for example those designating organic foods.

3. Chemical industry: Smart inventory management

Supply chain in the chemicals industry presents a number of daunting challenges. As in other industries, supply chains are often global and complex. They can also contain hazardous materials, making safety a major concern. All this adds cost and complexity. Chemicals producers often have long lead times from when a product is made to when it is used. To help, the industry has been turning to Vendor Managed Inventory (VMI) approaches, meaning the producer actually warehouses the product at the customer's premises. The materials still, however, belong to the producer; the customer only pays when it actually consumes the product. This approach offers a number of advantages for both parties. But it can also cause problems for producers. Firstly, producers are not paid when the product arrives, but only when it is used, based on measurements of consumption in the vats or silos. This leads to a "cash flow/goods flow" asymmetry. Because it is costly to measure bulk goods, inventory tends to be done monthly. While banks have traditionally been willing to provide financing on the basis of this kind of pre-sold inventory, due to increased regulation since the financial crisis, they have upped their standards in terms of being able to verify the inventory data being supplied to them.

A combination of IoT and blockchain can address these issues. Today it is possible to use sophisticated sensors to measure bulk chemicals inventories. This can provide near real-time data on customer usage down to the silo level, something that was not possible before. By connecting these sensors to a blockchain, this data can be captured and secured as it is created. This opens up different possibilities. For example, it could be possible to use smart contracts to trigger payments based on actual usage on a much more frequent basis. Alternatively, banks may find this data trustworthy enough to use as a basis for financing. Such data has other benefits as well, as it provides a more transparent, more timely overview of inventory and customer usage.

4. Pharmaceuticals: Combating counterfeiting and simplifying compliance

Pharmaceuticals is another industry with complex, global supply chains in which safety is a major concern. Among other things, the industry has been under intense pressure to fight counterfeit products and to

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check abuse in its supply chain. The World Health Organization estimates that 10% of drugs consumed in developing countries are substandard or counterfeit.[2] Regulatory response has included the EU's Falsified Medicine Directive asking every manufacturer to register the unique identifier of each package containing pills and drugs in a central repository and record every movement of the packages there. The Drug Supply Chain Security Act in the US addresses similar concerns. Pharmaceutical companies are also interested in fighting price arbitrage, where their distributors buy drugs in a market that is cheaper and then distribute in the market for which they have an agreement with the pharmaceutical company.

The implementation of a blockchain could solve many of these issues. As a drug moves through the supply chain the transactions can be recorded on a blockchain, thereby providing a distributed provenance ledger. This will make it harder for counterfeit drugs to be introduced into the supply chain and distributed to unsuspecting consumers. As with chemicals, pharmaceuticals can be monitored throughout the supply chain using smart IoT devices, and temperature, humidity and other factors can be recorded using smart devices throughout the supply chain life-cycle as well. This can help not only with ensuring quality, but the increased transparency can mean optimisation of flows and traceability makes accountability easier, in turn helping with efficient recall management.

5. Retail: Loyalty programmes and customer engagement

In the competitive world of retail, brands are always interested in increasing customer engagement and loyalty. Popular ways to do this include loyaty programmes and programmes designed to allow customers to actively engage with the products they buy. There is great potential for blockchain overall in loyalty programmes. Such programmes are often complex, expensive to set up, and siloed: points earned in one programme cannot easily be redeemed in others. Here blockchain-based platforms could provide a cost-effective means to standardise loyalty programmes and, through tokenisation, help make them more interactive.

One interesting trend in customer loyalty that is more directly related to supply chains, and for which blockchain technology could provide robust solutions, is the "tip the farmer" or "tip a social project" use case. The idea is always similar: a consumer buys a product and he or she can interact with it by scanning a QR code and then, for instance, learn about its provenance – perhaps information, sourced directly from the farmer, about how and where an organic product was grown and harvested. Additionally, by interacting with the product, the consumer can also earn tokens (similar to loyalty points). He or she could then choose to donate these to a charitable project or to the farmer involved in producing the good. The consumer can on the one hand learn about the whole history of the product and on the other hand "close the loop" by donating back to the source. At the same time, brands can demonstrate the quality of their products and position themselves a customer-centric. In this scenario, blockchain could be used to help make this information available and trustable along the supply chain as well as to create and exchange tokens and automate processes through smart contracts.

2 1 in 10 medical products in developing countries is substandard or falsified, World Health Organizatio, 28 November, 2017.

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6. Luxury goods: Enhancing brands through the aftermarket

The luxury goods sector has developed a great deal in recent years, transforming into a global industry manufacturing and selling products all over the world. As a result, luxury goods supply chain networks have become extremely complex, with suppliers and points of sales spread out over many countries. The industry also has to deal with a highly demanding customer base, one that insists on the highest quality of products and services in exchange for the premium prices it pays. In such an environment, counterfeit products can be a major issue, threatening a company's credibility and with it its bottom line. On the other hand, being able to prove the authenticity and sustainability of products can greatly burnish a brand and be turned into a potent marketing instrument. Unlike in many other industries, the after market is also very important for luxury goods manufacturers in terms of brand recognition and reputation. For luxury brands, anti-counterfeiting is not just a question of traceability on the upstream part of the chain in terms of raw materials but also a question of gaining visibility into and traceability in second-hand markets.

Blockchain could support the luxury aftermarket by providing a bona fide certification of a product's lifecycle. Provided every action performed on the product, from its creation through the original sale, any repairs or modifications, and subsequent changes of hand, are recorded on the blockchain, products could be sold or resold along with a highly trustworthy digital certificate. Once purchased, the certificate could also be useful for owners as a maintenance record, for insurance purposes, or when they would like to sell the item. This information would also be very useful for manufacturers trying to better understand their product's lifecycle and the preferences of their clients. Provided owners willingly divulge their identities, the information on the certificate could also be used by brands for cross-selling or to support brand loyalty.

7. Renewable energy

Renewable energy markets have experienced significant growth over the past decade and are positioned to continue expanding due to enabling policies, increasing consumer demand, technological advancements and cost reductions.[3] However, to catalyse investments to meet the goals of the Paris Agreement and unlock access to renewable energy, the process of tracking and reporting renewable energy investments must be simplified, disintermediated and modernised. Currently, renewable energy markets depend on certificates of origin, including the guarantees of origin (GOs) used in the European Union, renewable energy certificates (RECs) used in the United States and international renewable energy certificates (I-RECs) in about 25 countries. These certificates of origin provide detailed proof for each megawatt-hour (MWh) of renewable generation, and are required because once electrons enter the shared electric grid, it is impossible to distinguish whether they were generated by renewable or fossil fuel resources. There is a need to improve the operation of existing renewable energy markets, and the certificate-of-origin markets underpinning them so that they, for example, better enable smaller renewable energy generators and buyers to aggregate their supply and demand to gain greater market access.

Here too blockchain's ability to provide transparent, trusted shared data in

3 Bloomberg NEF. 2018. New Energy Outlook 2018–BNEF's Annual Long-term Economic Analysis of the World's Power Sector Out to 2050.

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heterogeneous environments could be employed, for example in certificate-of-origin systems geared to streamlining the documentation of carbon mitigation impacts of new renewable energy projects.

Look ahead

We seem to be at a tipping point when it comes to blockchain in the supply chain and trade finance fields.

As we have seen, there are many projects already underway, and a fair amount of them are live to some degree. We can expect these to mature. That said, a lot of the heightened expectations that were seen in the past have hit the realities of implementation, either technical or organisational. This is normal with new technologies, and here too we can expect hurdles to be overcome and progress to be made.

Much of this will happen under the radar and for smaller groups. For mass adoption, we will have to wait for one large-scale solution to demonstrate its viability. This should have a knock-on effect. The ingredients for such a success do, however, seem to be in place.

One example is the ongoing convergence of blockchain with IoT. We are seeing increased use of sensor technology along supply chains and the integration of their data into blockchain-based platforms. This is happening particularly in the upstream part of supply chains. While no panacea, the use of sensor technology will go a long way to addressing the data on-ramp issues that blockchain itself cannot.

While this has often proved easier said than done in the past, we are now seeing a great deal of progress on consortium building as people become more familiar with blockchain technology and consortia concepts and less wary of “coopetition”. Consortia will continue to be the main catalysers of adoption in this space over the near to mid term.

Enterprises, however, will not be the only catalysers. We can expect consumers to continue to put pressure on brands for more transparency and trust in products. These will continue to find blockchain-based solutions attractive in both supplying that trust as well as potentially opening new business models in the primary and secondary markets.

Last but not least, we expect regulation to continue to be a catalyst for supply chain and trade finance innovation, and so support blockchain adoption.

Conclusions and recommendations

To conclude, we would like to look at some of the ways policy makers and practitioners can foster innovation in Europe in terms of the development and adoption of blockchain for supply chains.

FOR GOVERNMENTS

It has been gratifying to see how the EU has taken blockchain seriously. Numerous initiatives, including the EU Blockchain Observatory and Forum, INATBA and the European Blockchain Partnership, are designed to help policy makers better understand blockchain technology and the needs of the blockchain industry. We encourage this trend and recommend those authorities directly involved in supply chains, like customs, excise and various regulatory agencies, do likewise (as many have) by taking a proactive approach to educating themselves and understanding the potential of this technology in their particular spheres.

Similarly, Europe should continue its support of research and development in blockchain. To foster development in the supply chain space specifically, we recommend supporting research in the areas of the interoperability between different blockchains, as this will be important in connecting smaller, consortia-based platforms with each other and so allow for cross-platform transacting. Policy makers should also support work to foster interoperability between blockchains and other technologies like AI and IoT. For example, research into using IoT sensors in blockchain contexts could prove of great use.

Successful implementation of blockchain in supply chains will also require dialogue and cooperation between many different stakeholders. Governments could foster such "non-technical interoperability" by coordinating dialogue between different actors through initiatives, workshops and roundtables. Governments could get more hands-on in supporting dialogue, as well as providing incentives to adoption, by joining or even helping to build industry consortia.

Governments could also foster understanding and adoption by using blockchain themselves. This could be particularly effective in cross-border trade settings. The EU, for instance, could back a series of projects that bring together ecosystems in which port authorities, customs officials and other agencies can be involved "hands-on" by signing blockchain transactions. Governments could also use blockchain to bring transparency and security to government procurement efforts – in essence using blockchain in their own supply chains. Governments should also explore blockchain as a regulatory and public safety tool to help them monitor supply chains in a more thorough and timely way than they can today, and so fight fraud and increase public safety.

Last but by no means least, governments, policy makers and regulators should continue their work to clarify the myriad legal, regulatory and standards-setting issues that have arisen.

Many of these are generic, not specific to the supply chain context. As we have written

elsewhere[1], there is much to be done in clarifying the legal validity of blockchains as registries and of blockchain-based contracts, signatures and timestamps. Getting fiat money on chain, either through central bank digital currencies or stable coins, would be a great boon to blockchain-based transactions. Governments should be thinking about digital assets generally and the legal and regulatory issues around "digital twins".

Looking specifically at supply chains, developing standards around digital identities for companies, products and materials would greatly facilitate the implementation of blockchain-based solutions. The same is true of various kinds of credentials, like licences or certificates, that are necessary along the supply chain.

FOR COMPANIES

Educating themselves about the technology is the necessary first step for companies too. This has to happen on all levels of an organisation, from the CEO and CIO level through the development and operational layers needed to successfully implement a solution or take part in a consortium.

Companies interested in joining supply chain consortia will have to develop a "co-opetitive" mindset and get used to the idea of partnering with competitors. This can be challenging. If done right, consortia can bring great benefits to all parties, but they are not without risks. Companies will have legitimate concerns about their proprietary data or the adverse effects of "too much" transparency. While there are solutions on the horizon to allow the best of both worlds, many of these approaches are still new. Companies should be open to exploring them, as well as to exploring the new kinds of governance challenges – and opportunities – that consortia bring with them.

When approaching any blockchain project, whether standalone or as part of a consortium, there are some best practices that are being recognised,[2] and companies should keep track of developments in this regard. A successful blockchain project should always have a clear scope and clarity on the added value it brings before development work begins. Blockchain has great potential benefits in many areas, but it is no panacea. It rarely makes sense to use it in cases where other, more established and proven technologies would suffice.

Last but not least, we would recommend companies to look not just at blockchain technology and use cases today, but to keep an eye on its potential for the future. As we outlined above, there may be competitive advantages in being able to prove provenance, increase transparency or discover new business models based on blockchain. Being an early adopter could reap rewards. Missing out, on the other hand, risks falling behind.

1 See Legal and regulatory framework of blockchains and smart contracts, EU Blockchain Observatory & Forum, 27 September 2019.

2 See Scalability, interoperability and sustainability of blockchains, EU Blockchain Observatory & Forum, 6 March 2019.

Appendix 1 – Example projects

As there is a great deal of activity in the blockchain for supply chain and trade finance space, we thought it useful to point the reader to specific projects addressing the various use cases we outlined in our discussion above. This list is intended to be indicative, not exhaustive. **Inclusion is neither an endorsement nor any indication of the superiority of a particular solution over any other.** There is no doubt that in many cases we could have chosen other, equally viable examples.

SUPPLY CHAIN PROJECTS

In our section above entitled "How blockchain can be used in specific industries" we highlighted a number of sector-specific blockchain for supply chain use cases. Below are some example projects addressing those scenarios.

1. Oil & Gas: Performance-based contracts

Ondiflo[1] has recently completed a pilot that illustrates in a small way how performance-based contracts can be handled in the oil and gas industry. When drilling for oil on land one by-product is lots of water that has to be hauled away. This requires a great deal of coordination with hauling companies, whose trucks have to be dispatched to the right wells at the right time. The work then has to be invoiced, which requires parties knowing how much water was really hauled and when. Ondiflo conducted a pilot with BP in Texas using a permissioned version of the Ethereum blockchain to build an automated platform for fluid hauling aiming to optimize these field tracking activities. In the pilot, tank-level data received from sensors, service orders, field tickets and invoices as well as regulatory documentation, were saved to the chain and then transacted via smart contracts.

Airline fueling: In Russia, **Gazpromneft-Aero** and **S7 Airlines**[2] have developed a blockchain-based system to allow aviation companies to make instant payments for fuel at the time of refuelling aircraft, without having to make any pre-payments or provide bank guarantees, and without any financial risks to the parties involved. Using what they call

1 ondiflo.com
2 Gazprom Neft and S7 Airlines become the first companies in Russia to move to blockchain technology in aviation refuelling, Gazprom Neft, 24 August 2018.

aviation fuel smart contracts (AFCS), S7 Airlinea can send information on its refueling plans via the blockchain to Gazpromneft-Aero, which can then send a ticket to a tanker driver at the airport with the projected amount of fuel needed. At the time of refueling the pilot enters the actual amount needed into the system, triggering an application to the airline's bank to block the required amount of funds. Confirmation of the blocked funds starts the refueling process. Once the refueling is completed, payment is immediately carried out.

2. Food: Trust in origin and quality

One of the best-known projects in this space is the **IBM Food Trust** consortium,[3] which includes an ever-expanding group of leading food companies, including Dole, Driscoll, Golden State Foods, Kroger, McCormick and Company, Nestlé, Tyson Foods and Walmart. Using Hyperledger Fabric, IBM is combining "supply chain modules with blockchain core functions" to offer blockchain-based tools which can be used to ensure "the complete history and current location of any food item along with its accompanying information (i.e. certifications, test data, temperature data) can be readily available in seconds."

Another interesting approach has been that from **Origin**[4], a project led by Bureau Veritas, a process and quality auditor who is currently controlling and certifying activies throughout global supply chains for food and other industries. The first implementation was done for tunafish captured in the Pacific ocean. The platform, developed by Worldline over a Multichain permissioned blockchain, provides not only a flexible approach to product traceability, but it also integrates a smart auditing element. Smart auditing uses the information collected in real time by the platform to analyse current reporting behaviours against previous ones. If something is identified as relevantly different, it is red flagged and the auditors focus on it in order to check it, in person if required. This substitutes the older blind controls and is more likely to spot potential issues so that they can be resolved before they generate a real problem. Remote or physical audit information is included in the shared platform and available to the rest of the supply chain participants and to the end-consumer, who are allowed access as well.

In July 2019, **ScanTrust**[5] and **Unilever** launched a blockchain-based food traceability application in Vietnam for the Knorr soup brand, which allows consumers to scan a QR code and check the full journey of the

3 IBM Food Trust
4 originprotocol.com/en
5 scantrust.com

provenance of the pork meat in their soups. The main focus lies on providing a proof for the claim that Knorr sources only from clean pork farms. The project is a production-scale implementation covering several million units of Knorr soup packs that are scanned by consumers every day. The main benefit of the project is the ability of Knorr to position itself as a clean pork brand against its competitors, and so build a trusted connection to their end consumers.

3. Chemical industry: Smart inventory management

Azhos[6] is a German blockchain startup that has been active in the chemicals space. Its platform connects with sensors to provide "proof of existence" for chemicals inventories. Deployed onsite in vendor managed inventory (VMI) implementations, the Azhos platform can be used either to provide trusted data to banks in real time and automate financing (for example through factoring bids), or to automate payments in fiat currencies through blockchain-based smart contracts.

4. Pharmaceuticals: Combating counterfeiting and simplifying compliance

A large number of projects are currently working on blockchain-based pharmaceuticals solutions. These include:

- **Rubix**,[7] a spinoff of Deloitte, is working in Canada with pharmaceutical companies to build applications for drug safety, drug channels, and public safety.
- US-based startup **iSolve**[8] has developed **BlockRx**, a private-blockchain solution for the life-sciences industry that provides traceability in drug supply chains. BlockRx's goal is to connect systems that do not readily communicate, establish data provenance that satisfies regulatory and business requirements, and create a network of trading partners that are incentivised to facilitate the transfer of information within a secured environment.
- **Blockverify**,[9] a UK startup, has developed anti-counterfeit solutions that may make the verification of a drug's authenticity as easy as scanning a bar code with a mobile phone. Each product will have its own identity on the blockchain to record changes of ownership, and will be accessible to everyone.
- **Chronicled**,[10] a California company, builds open protocols and

6 azhos.io
7 Deloitte Blockchain.
8 isolve.io.
9 blockverify.io.
10 chronicled.com.

hardware and software solutions that incorporate blockchain's cryptographic technology with the Internet of Things, to ensure that transactions and actors cannot be falsified. Joined by Pfizer and Genentech in a strategic partnership to co-develop solutions, it recently launched **CryptoSeal**, a platform that provides tamper-proof adhesive seal strips containing a NearField Communication chip to seal and track shipments of drugs.

5. Retail: Loyalty programs and customer engagement

A startup in the Netherlands called **Moyee Coffee**[11] is using blockchain to help coffee farmers. Via a purpose-built blockchain, the platform tracks every transaction along the supply chain from "bean to cup", cutting out middlemen and reducing price volatiliy. Farmers receive mobile wallets so that they can receive payment directly from the end consumer, and end consumers have an option to tip the farmer or donate to programs that aid farmers.

6. Luxury goods: Enhancing brands through the aftermarket

Aura,[12] a platform initially built by LVMH, ConsenSys and Microsoft on Quorum, a permissioned version of Ethereum, and subsequently opened for participation to all major luxury brands globally, provides lifecycle history recording and proof of authenticity for luxury goods.

Arianee,[13] which has built its own proof-of-authority blockchain on top of Ethereum, is working to build a "global standard of the digital certification of valuable objects". Everledger, one of the older and more venerable blockchain projects, has built a platform to provide similar capabilities for diamonds, other gemstones, wine and critical metals and minerals used in batteries and electronics (in order to facilitate recycling).

7. Renewable energy

The **Energy Web Foundation (EWF)**[14] for example is developing **EW Origin**, an open-source and blockchain-based toolkit for certificate of origin trading and tracking systems, and running tests of real-world scenarios in several countries with various energy sector market participants. EW Origin can be used to build dApps that record

11 See How Moyee Coffee is helping farmers in Ethiopia, The Borgen Project.
12 LVMH creates blockchain platform to track luxury goods, RetailDive, 20 May 2019.
13 arianee.org.
14 energyweb.org.

provenance, support direct trading, track ownership, and create reports for the green attributes of renewably generated electricity at the kilowatt-hour (kWh) level, as well as the associated avoidance of carbon dioxide emissions. By adopting new technological tools that increase trust, simplify investment tracking, and reduce administrative costs, blockchain-based solutions like EW Origin should enable countries to leapfrog existing energy systems by encouraging more renewable energy investments.

In Switzerland, the **Quartierstrom**[15] project has developed a system that allows households in a Swiss town to buy and sell solar energy directly among themselves. Some 37 households have joined forces to form a local electricity market. Of these, 28 participants have their own solar power systems, and nine are pure consumers, including a retirement/ nursing home. Participating households can use a web app to specify their individual preferences for buying and selling energy within the community. The solar power system operators determine the conditions under which they would like to market their surplus solar power to the neighbourhood. Electricity consumers, on the other hand, specify the maximum price at which they would like to purchase electricity from within the neighbourhood.

TRADE FINANCE

As pointed out in a recent report by Trade Finance Global,[16] while the trade finance industry has been even slower to digitise than supply chain, post-financial crisis pressure on banks and the rise of competition from fintechs have catalysed a great deal of movement lately. Blockchain is seen as a key technology in this regard, with a number of significant projects and consortia coming online. Among the more notable as pointed out in the report are:

- **Komgo**.[17] Komgo is a commodity trade finance platform built on Quorum and currently running live in a consortium of major banks, commodities traders and energy majors. It aims at optimizing financing processes and accelerating industry operations with digitized transactions and a trusted source of documents to reduce fraud.
- **We.trade**.[18] A joint venture of 12 European banks (originally known

15 quartier-strom.ch.
16 Blockchain and Trade Finance, Trade Finance Global, Trade Finance Global.
17 komgo.io
18 we-trade.com

as Digital Trade Chain or DTC), we.trade has build a platform based on Hyperledger designed to digitise the management, tracking and security of domestic and international trade transactions.

- **Marco Polo**.[19] A consortium of over 20 banks, Marco Polo utilises R3's Corda DLT platform to support trade and working capital finance solutions. These include receivable finance, factoring, and payment commitment with and without financing. The platform also provides secure, distributed data storage and bookkeeping, identity management, and asset verification.
- **Vakt**.[20] Vakt, also run on Quorum, is a blockchain-based post-trade platform designed for the oil industry. It is a post-trade platform handling such processes as deal recap, confirmation, contract, logistics, and invoicing. In partnership with Komgo's commodity trade financing network, Vakt focuses on the actual raw material transaction.
- **CargoX**.[21] CargoX offers an on-chain bill of lading platform on Ethereum, as well as a Blockchain Document Transaction System (BDTS) open source protocol to facilitate the tokenisation, encryption and transfer of bills of lading and any other additional documents required for trade processes. The platform can reduce what used to be 5-10 day document transport times to mere seconds.
- **TradeLens**[22]. Jointly owned by IBM and Maersk and using Hyperledger Fabric, TradeLens is a platform for containerised shipping, connecting the entire supply chain ecosystem. It consists of various organisations including carriers, ports, terminal operators, and freight forwarders.
- **eTrade Connect**[23]. An Asia-Pacifi consortium, eTrade Connect is managed by the Hong Kong Monetary Authority and also uses Hyperledger Fabric. The consortium aims to build better trust among trade participants, improve efficiency, reduce risks, and facilitate trade financing by digitising trade documents and automating processes.

19 marcopolo.finance
20 vakt.com
21 cargox.io
22 tradelens.com
23 etradeconnect.net/Portal

Appendix 2 – Blockchain Terminology

What is a blockchain?
Blockchain is one of the major technological breakthroughs of the past decade. A technology that allows large groups of people and organisations to reach agreement on and permanently record information without a central authority, it has been recognised as an important tool for building a fair, inclusive, secure and democratic digital economy. This has significant implications for how we think about many of our economic, social and political institutions.

How does it work?
At its core, blockchain is a shared, peer-to-peer database. While there are currently several different kinds of blockchains in existence, they share certain functional characteristics. They generally include a means for nodes on the network to communicate directly with each other. They have a mechanism for nodes on the network to propose the addition of information to the database, usually in the form of some transaction, and a consensus mechanism by which the network can validate what is the agreed-upon version of the database.

Blockchain gets its name from the fact that data is stored in groups known as blocks, and that each validated block is cryptographically sealed to the previous block, forming an ever-growing chain of data. Instead of being stored in a central location, all the nodes in the network share an identical copy of the blockchain, continuously updating it as new valid blocks are added.

What is it used for?
Blockchain is a technology that can be used to decentralise and automate processes in a large number of contexts. The attributes of blockchain allow for large numbers of individuals or entities, whether collaborators or competitors, to come to a consensus on information and immutably store it. For this reason, blockchain has been described as a "trust machine".

APPENDIX – BLOCKCHAIN TERMINOLOGY

The potential use cases for blockchain are vast. People are looking at blockchain technology to disrupt most industries, including from automotive, banking, education, energy and e-government to healthcare, insurance, law, music, art, real estate and travel. While blockchain is definitely not the solution for every problem, smart contract automation and disintermediation enable reduced costs, lower risks of errors and fraud and drastically improved speed and experience in many processes.

Glossary

The vocabulary used in the context of blockchains is quite specific and can be hard to understand. Here are the essential concepts you should know in order to navigate this breakthrough technology:

- **Node:** A node is a computer running specific software which allows that computer to process and communicate pieces of information to other nodes. In blockchains, each node stores a copy of the ledger and information is relayed from peer node to peer node until transmitted to all nodes in the network.
- **Signature:** Signing a message or a transaction consists in encrypting data using a pair of asymmetric keys. Asymmetric cryptography allows someone to interchangeably use one key for encrypting and the other key for decrypting. Data is encrypted using the private key and can be decrypted by third-party actors using the public key to verify the message was sent by the holder of the private key.
- **Transaction:** Transactions are the most granular piece of information that can be shared among a blockchain network. They are generated by users and include information such as the value of the transfer, address of the receiver and data payload. Before sending a transaction to the network, a user signs its contents by using a cryptographic private key. By controlling the validity of signatures, nodes can figure out who is the sender of a transaction and ensure that the transaction content has not been manipulated while being transmitted over the network.
- **Hash:** A hash is the result of a function that transforms data into a unique, fixed-length digest that cannot be reversed to produce the input. It can be viewed as the digital version of a fingerprint, for any type of data.
- **Block:** A block is the data structure used in blockchains to group transactions. In addition to transactions, blocks include other elements such as the hash of the previous block and a timestamp.
- **Smart contract:** Smart contracts are pieces of code stored on the blockchain that will self-execute once deployed, thus leveraging the trust and security of the blockchain network. They allow users

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to automate business logic and therefore enhance or completely redesign business processes and services.

- **Token:** Tokens are a type of digital asset that can be tracked or transferred on a blockchain. Tokens are often used as a digital representation of assets like commodities, stocks and even physical products. Tokens are also used to incentivise actors in maintaining and securing blockchain networks.
- **Consensus algorithm:** Consensus algorithms ensure convergence towards a single, immutable version of the ledger. They allow actors on the network to agree on the content recorded on the blockchain, taking into consideration the fact that some actors can be faulty or malicious. This can be achieved by various means depending on the specific needs. The most famous consensus algorithms include proof-of-work, proof-of-stake and proof-of-authority.
- **Validator nodes:** Validator nodes are specific nodes in a network that are responsible for constituting blocks and broadcasting these blocks with the network. To create a valid new block they have to follow the exact rules specified by the consensus algorithm.

Learn more about blockchain by watching a recording of our Ask me Anything session.