



Blockchain Disruption

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Executive Summary

This paper explores the disruptive nature of Blockchain technology, in particular, how it is affecting the supply chain industry, which can greatly benefit from its distributed and transparent nature.

The research points to the undeniable potential of Blockchain to revolutionize many industries, drawing a parallel to the evolution of the Internet and all the services that it now supports. Blockchain is built on the communication infrastructure of the internet and the available distributed computing resources. It addresses the problem of establishing trust among unknown parties over an untrusted communication network. The most widely adopted implementation of Blockchain technology, Bitcoin cryptocurrency, was met with skepticism and strong resistance from financial services incumbents. The idea of a world in which currency could flow over the Internet without relying on banks and intermediaries and without regulation by governments was not well received. Bitcoin did not disrupt the fintech industry but it ignited a race for Blockchain platform services due to its applications across many industries. It's predicted that 80% of banks will initiate related projects in 2017.

Research indicates that the supply chain industry is a prime candidate that can benefit from Blockchain. It has complexities with the multitude of participants, from suppliers and manufacturers to distributors and retailers, many of which only interface with its immediate counterparty the supply chain. The ability to "see" further up or down the chain would greatly improve speed and allow participants to react to unexpected events. When keeping track of paperwork costs more than moving goods around the globe it's a sign the current process is vastly inefficient, costly and doesn't scale.

Disruption in Supply Chain may start with moving the paperwork to Blockchain, then cutting off unnecessary steps and optimizing necessary ones through automation, and finally with the arrival of shared and distributed manufacturing (Industry 4.0) Blockchain will play a significant role in intellectual property protection, smart factories and composite assembly lines.





1. Trust is expensive

Throughout human history, and more specifically communication and transactions, trust has always been a barrier to efficiency and speed. There is a constant requirement to validate authenticity of the counterparties and the content or transaction itself. Consumers and businesses research products and services they purchase before they make a decision, to filter out the marketing materials to ensure it matches their requirements. *The SPEED of Trust: The One Thing that Changes Everything* by Stephen Covey (New York, NY: S. M. R., & Merrill, R. R. 2006) describes how corporations are operating at a fraction of their potential when little to no trust exists within the organization. The complex supply chain for products and services contains many possible transactions between counterparties. There is a large opportunity for Distributed Ledger Technology (DLT), or more commonly known as Blockchain to simplify the supply chain and ultimately lower the costs of the goods and services.

The supply chain today is a collection of bilateral contracts between parties involved in the sourcing, processing, distribution, and delivery of a product or service. These are typically conducted in serial with little to no transparency outside of the immediate parties. This makes it difficult to manage supply and demand or for any party to react to problems with points in the chain beyond their immediate visibility. Intermediaries facilitate transactions with financial, legal, information technology, and certifications through governing bodies. Each link as shown in Figure 1.0 can be a bottleneck for the flow of information. In 2015, US businesses spent 1.48 trillion USD on logistic expenses, which creates a huge opportunity, and potential return on investment for a disruption throughout the supply chain (Schulz, J., 2016. *State of Logistics 2016: US Businesses Logistics Costs Slow Considerably with 2.6% Growth*. Web 23 April 2017. http://www.logisticsmgmt.com/article/state_of_logistics_2016_us_businesse_logistics_costs_slow_considerably_with)



Simplified Supply Chain

Figure 1.0





A more realistic view of a supply chain which depicts the complexities comes from Charoen Pokphand Foods (CPF), an agro-industrial and food conglomerate in Thailand, one of the largest in the world

(Seaman, T., 2014. *CP Foods Plans to expand IFFO-Certified Tuna Meal Model with KingFisher to Other Plants*. Web 23 April 2017.

https://www.undercurrentnews.com/2014/09/25/cp-foods-plans-to-expand-iffo-certifie d-tuna-meal-model-with-kingfisher-to-other-plants/).

Figure 1.1 depicts the highly complex feed supply chain the company is seeking to improve.



Charoen Pokphand Foods Supply Chain

Source: Sal Forest Report submitted to Oxfam (March 2014); CPF study

Figure 1.1





2. Brief Description of Blockchain

Blockchain is a type of distributed ledger technology enabling the digital recording of data in blocks that are back-linked forming a sequence of immutable records in a chain. Using Blockchain, computers in a network, called nodes, can operate in a truly peer-to-peer mode, without any kind of central coordination or clearing house.



Intermediaries Compared to Peer to Peer

Source: http://tidbytes.bytesofknowledge.com/blog/remove-the-middleman-with-the-blockchain-gang Figure 2.0

The technology allows for the establishment of trust among unknown participant nodes in a network by providing transparent access to the history of transactions, guaranteeing the order in which they happened and a mechanism to verify the records were not tampered with, in practice eliminating the need for central authority and a single point of failure. It was originally designed to support secure transactions for the Bitcoin digital currency but now it is being applied in many other areas too, where secure transactions are needed.





Distributed consensus on the validity of blocks in the chain is reached in much the same way a group of humans reach consensus. All peers in the network share a copy of the chain, and using cryptographic hash functions, they can inspect the hash values in each block to ensure data hasn't been mutated. Also, each block includes the hash, or digital signature, of the previous block, causing the tampering with data in one block to invalidate all subsequent blocks.

Any node can group transactions into a block and broadcast it as a suggestion to be included as the next block in the chain. Since any node can suggest a new block, a mechanism for distributed consensus is needed. New blocks are added to the chain upon one node solving the mathematical challenge of finding a hash value for the block satisfying the Blockchain criteria, e.g. a hash value digital signature below a certain number, called difficulty target. These challenges are solved by miners, node computers in the network that try to find a random number called "nonce", added to the block data so that the block's hash value satisfies the Blockchain's target difficulty. The validated new block is added to the chain and broadcasted to the network. Miners are incentivised to perform these costly computational operations in exchange from assets (in case of cryptocurrency) and transaction fees paid by the entities transacting.

This is all true for public Blockchains while private Blockchains can benefit from having trusted partners in the network directly transferring assets between two peers, eliminating transaction validation but still enjoying the benefits of transparency and trusted audit trail with the added benefit of speed and scalability.

3. Blockchain and the Internet

Today it is almost unthinkable to picture the world without the Internet and it is hard not make parallels with Blockchain. The internet started as a Department of Defense project to address the risk of a total breakdown in communication in case of a nuclear attack and it's on pace to become the main communication infrastructure replacing the backbone of established services like telephony and TV, while supporting native Internet application such as email, web browsing and social media which are now ubiquitous and indispensable.

The Internet changed the way the world interacts and does business in so many ways. A select few recognized the potential early on with the first web browser appearing in 1989, followed by Netscape in 1993 and 15 years later, Web 2.0 with online applications as shown in Figure 3.0. Ordering toilet paper on Amazon or Google Express is so much easier than driving to a store, isn't it?







Parallels with the evolution of the Internet

Bitcoin went live in 2009 and 5 years later it is here to stay. It may not have disrupted the entire financial system but it made everyone pay attention. Financial institutions that are not looking into Blockchain technology are likely to be at a disadvantage. Like the Internet is not a "killer app", but rather an enabler for many types of applications demanding a flexible and far reaching communication infrastructure, Blockchain is emerging as a foundational technology for transacting with trust and transparency, eliminating "too big to fail" middle-man enterprises and bottlenecks created by the bureaucracy inherent to many industries.

We are now experiencing Blockchain 2.0 with application development on Blockchain technology. For example, digital smart contracts that execute automatically based on triggers such as material delivery or completed payments. The supply chain industry is the perfect candidate to be disrupted by this technology reducing much of the complexity we discussed earlier.





Figure 3.0

4. State of affairs with Blockchain technologies

A lot has been said about Blockchain and how it will disrupt many industries. Its effect is being compared to the relational databases, or even the Internet, as mentioned previously.

In 2016, the Blockchain buzz reached new heights. Absent from Gartner's 2015 Hype Cycle for Emerging Technology, Blockchain skyrocketed into the 'Peak of Inflated Expectations', sneaking past IoT Platform and Smart Robot, to name a few (*Gartner's 2016 Hype Cycle for Emerging Technologies Identifies Three Key Trends That Organizations Must Track to Gain Competitive Advantage*, 16 August 2016. Web 23 April 2017. http://www.gartner.com/newsroom/id/3412017).



http://www.gartner.com/newsroom/id/3412017

Figure 4.0

Gartner believes Blockchain technology is 5 to 10 years from mainstream adoption but recognizes its transformational impact on business and there are now dozens of distributed ledger products in the market. Blockchain is considered an example of ann enabling technology that is part of the platform revolution, one of the three major trends in Gartner's Hype Cycle for Emerging Technology report.





Based on the following three observations, all indicators point to a disruption that is starting to take place now:

4.1 Investments in start-ups:

As reflected by the influx of capital invested by Venture Capital Funds (Figure 4.1), and its rapid acceleration, even though Financing to US VC-backed companies continues to drop off (Figure 4.2), many industries are about to get disrupted by the myriad of technology start-ups being funded (Figure 3.3).

According to a report by the World Economic Forum, dated Aug. 2016, over \$1.5 billion has been invested on Blockchain technology in the last 4 years, Figure 4.1.

2012: \$2.13 MM, 2013: \$95.05 MM, 2014: \$362.53 MM, 2015: \$488.08 MM, 2016: \$500 MM.









PwC | CB Insights MoneyTree™ Report Q4 and Full-Year 2016

Figure 4.2

Source: CBInsight

https://www.cbinsights.com/reports/MoneyTree-Q4-2016.pdf?utm_campaign=Report%20-%20Content%20Emails&utm_source=hs_automation&utm_medium=email&utm_content=40410124& hsenc=p2ANqtz-8SsUW8sHnaQzry5jK25BM1rjaFqj-LgrmL_vVjLoqLZa a2gscu5lwePNhvxnUs-wNI7njX3a1H3BDtB_UuK8npXw-xKA& hsmi=40410124

Investors are not shy about underscoring the big opportunity:

"The Blockchain's distributed consensus model is the most important invention since the Internet itself".

Mark Andreessen (Netscape founder, Andreessen Horowitz VC firm founder)

"I do think Bitcoin is the first [encrypted money] that has the potential to do something like change the world."

Peter Thiel, Co-Founder of Paypal.







Figure 4.3

4.2 New source of revenue for established technology or consulting provider companies:

Large established companies are viewing Blockchain technology as a new source of revenue with the consulting and technologies sectors leading the way. Programmable transactions, instant consumption, identity protection, micropayments, immutability,





auditability are just the beginning of what can be done with this technology. In addition to venture capital investments, over ninety corporations have joined various Blockchain consortias. Two technology giants are racing to build their Blockchain as a service (BaaS) platforms. IBM and Microsoft already offer Blockchain enterprise services in their cloud platform, facilitating the development of solutions based on the technology with Microsoft founding the Enterprise Ethereum Alliance.

In March 2017, at an InterConnect event, IBM unveiled its vision, betting on Cloud, Artificial Intelligence and Blockchain. IBM considers the technology an essential tool for financial services, supply chain and global logistics.

"I believe Blockchain will do for trusted transactions what the Internet has done for information", said Ginni Rometty, IBM Chairman and CEO. Even with only a few customers, IBM is aggressively investing in Blockchain technology, as one of the premier members of the HyperLedger open source project, along with SAP, Intel and J.P. Morgan, among other heavy weights.

4.3 Consumer Adoption: Optimization, Cost Reductions opportunities

The opportunity to improve existing business operations, therefore reducing product and services cost, have triggered a great interest in this technology by consumers. Cost reduction in communication, IT security, resource management, finance, workflow and processes means that virtually every business is starting to consider Blockchain technology for their internal operations. The ability to create value in faster decision making and governance also means that the technology will be exposed to these companies's end users, via new products and services.

Large established Fintech companies are investing in this technology to become more efficient, and also create intellectual property on top of Blockchain.

Distributed Ledger Technology (DLT) is seeing investments in more than 24 countries, where more than 90 central banks are already engaged in DLT discussions with over 80 % of banks predicted to initiate DLT projects in 2017.

5. Landscape

The landscape of infrastructure providers is fragmented at best. In the early stages of the Blockchain, Bitcoin, the digital currency, brought to light the global benefits but also highlighted the inherent flaws with using a digital currency in a fiat currency world.

There are several consortiums and technology firms building Blockchain networks in





varying degrees of open platform architecture, but using the Blockchain to store everyone's banking data for all to see is not something many will adopt.

There are three main categories of Blockchain that describe the degrees of openness:

- **1.** Public Blockchains are fully decentralized with open access for anyone to participate.
- 2. Consortium Blockchains are only available to those that are members of a group, but still operate by consensus driven transactions between the private nodes.
- 3. Fully Private Blockchains is modeled around a single organization owning the write capabilities, but that may publish read for an audience or the general public. (Buterin, V. 7 August 2015. *On Public and Private Blockchains*. Web 23, April, 2017

https://blog.ethereum.org/2015/08/07/on-public-and-private-blockchains/

Many Blockchain startups and consortiums are aligning to one or multiple categories, supplying expertise and application development on top of the technology.

R3 is an example of a Consortium Blockchain. Headquartered in New York, NY, it has three pillars of a Blockchain ledger it is building its business on with over 80 financial institutions and regulators. Financial Grade Ledger, Lab and Research Center, and Product Development all make up their business model but their software, Corda, is not really Blockchain. Former Regulator, Charley Cooper says, "Our platform, Corda, is inspired by Blockchain technology, but is not technically a Blockchain in the purest sense. We're seeking to take the best attributes of Blockchain technology (data storage with transactions/events, immutability, asset representation, cryptography, and distribution/consensus) and apply them to financial services in a way that a pure, public Blockchain would be unable to do." (Roberts, J J. 7 July 2016. How Banks Will Stop Snoops From Using the Blockchain to Front-Run Trades. Web 23 April 2017 http://fortune.com/2016/07/07/blockchain-r3/). The solution targets to only store partial data on the custom Blockchain to avoid conflicts of public data between competing financial companies and is only available to the companies that are members of the consortium. This is similar to the several global and regional clearing networks in place today with SWIFT and Fedwire respectively. The only difference is the intermediary is not a central company but has distributed "ownership".

Ethereum is a decentralized platform that underpins the concept of smart contracts. Workflow is applied to an agreement when criteria is met such as a transfer of value





from one party to another or time lapses on a contract.

Due to the varying types of Blockchain infrastructure, it is unclear if a small number of companies will rise to be dominant players. Just like in the early days of the TCP/IP network protocol and Domain Name Service that the Internet is built on, Blockchain infrastructure will be decentralized based on its application. The real challenge is how to manage a private Blockchain and connect it to a public Blockchain, exposing only what you want.





6. Barriers to adoption for Blockchain infrastructure

As shown in Figure 6.0, we found that the barriers to adopting this new technology falls into two categories: cultural and technological.



Cultural challenges and Technology challenges



6.1 Cultural challenges:

Blockchain is bringing a major shift to the way business is being conducted. Its promise is to disintermediate business entities and to eliminate the middleman.

The middleman is resisting and may be the strongest barrier observed: resistance from intermediaries, being replaced by decentralized systems, is a natural reaction to change and promotes survival instincts. The technology is a direct challenge to business models that have been around for a very long time.

Risk averse regulatory bodies often do not keep pace with technology innovation. With the first application of Blockchain being a digital currency, the lack of explicit blessing from regulators was a major blocker in this case.

Bitcoin, the digital currency and first Blockchain application, enables people to conduct transactions without banks, transaction fees and the government involvement. Financial institutions pushed back, refusing to recognize the currency.





Major currencies such as the dollar or euro, backed by central banks, didn't have a digital cash equivalent. Furthermore, central banks wanted to insure from the very beginning that Bitcoin exchanges were not involved in market manipulation, that they had the proper licenses, and that they had implemented anti-money laundering systems.

The lack of regulatory support meant that the US authorities seized accounts of some of the early Bitcoin exchanges as they had not registered as "money transmitters" with the Financial Crimes Enforcement Network (FinCEN) in the United States (Dillet, R. 16 May 2013. *Feds Seize Assets From Mt. Gox's Dwolla Account, Accuse It Of Violating Money Transfer Regulations*. Web 23 April 2017.

https://techcrunch.com/2013/05/16/mt-gox-dwolla-account-money-seizure).

In the early days of this new digital currency, we can observe that regulatory challenges made the adoption more difficult, as shown in Figure 6.0





6.2 Technology Challenges:

a) Adopting a new technology:

The main challenge with any breakthrough technology is to get traction with users.

- Compatibility: One approach is to make it work with the existing ecosystem. But the lack of standard in the new technology ecosystem can make this approach very difficult. Even if the new technology works with existing applications, the fear of being locked into a proprietary technology will often scare users from adopting the new technology.
- Network effect: Another approach is to seed the ecosystem to reach critical





mass, even if the technology isn't standardized yet. If we look at Bitcoin again, its adoption falls into this second approach. As a classic four-sided network, the more people who use Bitcoin, the more valuable Bitcoin it is for everyone who uses it, and the higher the incentive for a new user to start using this technology. It is very similar to Web Services such as Facebook or eBay in that aspect. The four constituencies that participate in this network are the consumers who use Bitcoin to pay, the merchants who accept Bitcoin payments, the "miners" who validate all the transactions, enabling distributed trust in the process, and finally the developers and entrepreneurs building services and products on top of the Blockchain and Bitcoin ecosystem. What made Bitcoin's success, what seeded its adoption, was the speculation on the future use of that payment system; this in turn raised the price of the currency to a sufficiently high point that payments became possible with this new digital currency.

- b) Lack of standards
 - Proprietary technology: The lack of standardization, triggered the fear of being locked into a proprietary technology. Technology vendors recognized this challenge early on, having gone through similar challenges with the computing high technology revolution over the past 40 years.
 - One size doesn't fit all: The lack of options, tailored to specific industries, or challenges, meant that a specific implementation of the initial Blockchain technology was simply unusable for some applications. For instance, the public distributed ledger created for, and adopted by Bitcoin, was not appropriate for early Supply Chain applications. A private, or permission-based ledger with a smaller number of participants where trust would be high, would have been a better solution, but was initially non-existent.
 - Interoperability: Independent Blockchains are needed in many cases that drives the need for interconnectivity. Having the ability to have independent Blockchains interact with each other, in a standard way, is a necessity in applications like the Supply Chain (see "Sidechains" later on in this paper).

c) Security

- Secured processing: This is the basis for the Blockchain protocol. That being said, early security issues with a Bitcoin Protocol Bug caused a fraudulent transaction that generated 9000 times more bitcoins than could legitimately exist in the system, on August 15 2010. Even though the problem was quickly corrected, this caused the market to loose trust into the currency.
- Anonymous Blockchains are problematic: The fraudulent transaction listed above was created by an anonymous person. This also eroded trust in the system.
- Permission based vs. Public: The need for permission based solution, as opposed





to the initial public based solution adopted by Bitcoin greatly reduced the adoption of bitcoin for more traditional enterprise type of solutions.

- d) Scaling & Reliability challenges
 - Processing: The Low throughput, high latency challenges experienced by the early Bitcoin application highlighted a challenge that would have to be dealt with before Digital Currency at a global scale could be adopted. A myriad of issues, linked with Distributed Denial-of-Service (DDoS) attack on the largest bitcoin exchanges caused trade to fail, triggering panic-sell. Different approaches would have to be considered for this protocol to reach general use.

7. Overcoming the Barriers to Blockchain Adoption

The Blockchain ecosystem needs standard building blocks in order to be successful. Blockchain developers and entrepreneurs not only built Blockchain on top of the Internet ecosystem, but also followed its history and adopted its architectural approaches.

What made the Internet a success was the creation of standard and open protocols available and adopted by all at the infrastructure level (TCP/IP, DNS, HTTP), commercial and open source operating systems to run workloads (Microsoft Windows, Apple MacOS/iOS, LINUX), and the standard and open languages to create and run the applications (C, Java, Javascript).

7.1 The creation of a Blockchain Platform:

The same thing is happening with Blockchain, where both open source and commercial efforts are gaining traction in creating standards and solutions, such as Blockchain operating systems, APIs, and the protocols intended for multiple and varied use cases:

Open source:

• The Linux Foundation Hyperledger Project may be the most successful effort to date, aligning industry APIs and standards: <u>https://www.hyperledger.org/</u>; as of late February 2017, the Linux Foundation organization has 122 members with diverse companies such as: (Platinum & Gold Members) Cisco, Fujitsu, Hitachi, Huawei, IBM, Intel, Microsoft, NEC, Oracle, Qualcomm, Samsung, Accenture, Alibaba Cloud, Citrix, DellEMC, Doky, Facebook, Panasonic, Hart, Renesas, Suse, Toshiba,





Toyota, VMware, ... (full list of Silver Members available at: <u>https://www.linuxfoundation.org/members/corporate</u>)

 <u>Blockstream (https://elementsproject.org)</u> is an open source project with a focus on sidechains—interoperable Blockchains--to avoid fragmentation, security and other issues related to alternative crypto-currencies. Uses can range from registering securities, such as stocks, bonds and derivatives, to securing bank balances and mortgages.

Note that many research papers, addressing some of the blockers described earlier, are being shared, such as:

 Byzantine Vertical Paxos: BVP is a framework whose goal is to provide a method to produce high throughput Byzantine fault tolerant state machine replication: <u>https://research.vmware.com/publications/bvp-byzantine-vertical-paxos</u>

Having a vibrant and successful open source foundation is a necessary ingredient to the success of this new ecosystem, but it won't sustain growth by itself. Commercial innovation will be needed to address the specific use cases faced in various industries and sectors of the economy. We also see an incredibly rich environment emerging extremely rapidly, with hundreds of start-up and well established companies engaging tens of thousands of resources to create the solutions of the future. Some examples of commercial applications:

- <u>Gem</u> is building a Blockchain operating system and API for the financial, healthcare, and manufacturing sectors, among others, and has received \$10M in total funding from seed and Series A rounds. "Gem's enterprise platform allows companies and organizations to participate in these Blockchain data sharing networks."
- <u>Guardtime</u> is an Estonian startup focused on a Blockchain-based approach to industrial-grade cybersecurity. <u>https://guardtime.com/</u> A Ledger of Everything: An industrial Blockchain platform powering digital transformation
- VaultOS: <u>https://www.thoughtmachine.net/</u> fully integrated, Blockchain-based banking operating system

Note that many innovations, that directly address the barriers to Blockchain adoption, are being patented. Here are two examples:

• Interoperability: Transferring ledger assets between blockchains via pegged sidechains

http://appft1.uspto.gov/netacgi/nph-Parser?Sect1=PTO1&Sect2=HITOFF&d=PG0





1&p=1&u=/netahtml/PTO/srchnum.html&r=1&f=G&l=50&s1=20160330034

• Security: Cryptographically concealing amounts transacted on a ledger while preserving a network's ability to verify the transaction <u>http://appft1.uspto.gov/netacgi/nph-Parser?Sect1=PTO1&Sect2=HITOFF&d=PG0</u> <u>1&p=1&u=/netahtml/PTO/srchnum.html&r=1&f=G&l=50&s1=20160358165</u>

7.2 A Layered, Service Oriented Approach:

Blockchain leverages decades of innovation in the decentralized communication architecture of the internet. It also adopted a similar layered and service oriented approach for its architecture as shown in Figure 7.0. This allows for rapid innovation by creating new layers as the ecosystem evolves, as well as creating new services in existing layers to address specific challenges.

| | Application | HTTP SMTP DNS Telnet |
|--|----------------|---|
| that sits on top of the | Transport | TCP UDP |
| Internet | Internetwork | IP |
| | Network | Wi-Fi Bluetooh Ethernet |
| | | |
| II- Layered Approach: | Application | Bitcoin |
| Scalability, Performance, Evolution | Smart Contract | Smart Legal Agreements DAO: Decentralized Autonomous Organization |
| Lyonacion | | riatorionious organization |

Figure 7.0

This ability to customize a technology stack while following a standard based approach allows for new types of applications to be introduced, while still being able to leverage the overall ecosystem and participating in it. For instance, the shared ledger layer can now enjoy multiple implementation of this concept, based on this type of applications being on-boarded onto the Blockchain ecosystem:

Public & Permissionless - Censorship resistant type of applications (currency for instance):

Anyone can see and contribute data to the ledger: It's an Open network access.





All participants possess an identical copy of the ledger: It's an untrusted environment. We could compare that to the Open Internet Implications:

Slower and trust no one. Wait for consensus to validate a block and get agreement to enable anti-hacking mechanisms with miners maintaining the network.

Fully Private or Permissioned - Blockchains within a company that are not available to outsiders, or limited to a consortium (like Supply Chain applications), distributes identical copies of a ledger to the participants. This creates simplicity and speed while maintaining transparency. We could compare this to a corporate VPN type of solution. Implications:

Faster and trust everyone model with controlled entry to the network

7.3 Blockchain as a Service, Simplifying the Adoption

Now that a Blockchain platform is emerging on top of the Internet ecosystem, large cloud companies, as well as some of the largest consulting companies partnering with cloud providers, are starting to offer Blockchain as a Service (BaaS).

This makes it easier to experiment with the technology for integration to reduce the time to market for new Blockchain applications.

Some of the early providers, and leaders in that space include:

- Ethereum Blockchain as a Service by Microsoft Azure (EthBaaS) public blockchains
- Bluemix: IBM Blockchain
- <u>Rubix</u> by Deloitte
- Blockchain on AWS: leveraging existing services to enact a solution, partnering with PWC

8. Supply chain today

Today's supply chain is powered by legacy protocols and obsolete technologies leading to a series of issues.

8.1 Lack of transparency





According to <u>CSCMP 2016 report</u>, transparency grows in importance for shippers and third-party logistic providers and becomes a key technological differentiator (Schulz, J., 2016. *State of Logistics 2016: US Business Logistics Costs Slow Considerably with 2.6% Growth*. Web 23 April 2017.

http://www.logisticsmgmt.com/article/state_of_logistics_2016_us_business_logistics_c osts_slow_considerably_with).

By improving transparency alone, some of the benefits include:

- a) Flexibility (replace nodes in the chain upon necessity)
- b) Ability to reliably track origin and authenticity
- c) Increase opportunity for real time decision making in both reactive scenarios (e.g. loss of container, delays on customs, factory accident) and proactive scenarios (e.g. re-route excessive supply in the chain)
- d) Properly manage supply/demand balance, get closer to establishing demand-driven production model

8.2 Closed ecosystem

Today's supply chain practices sets high entry barriers which discourages new players from joining and motivate business models with less nodes involved. Along with that, closed ecosystem slows down improvements within the industry due to lack of incentives for existing players to disrupt themselves.

8.3 Expensive and inefficient

Market trends are continuously driving towards globalization with more parties involved. The complexities of regional and international contract laws make the transactions more laborious and expensive. Existing systems don't scale well as the ecosystem becomes exponentially difficult.

9. Supply chain with Blockchain

In a conventional supply chain, information flows linearly from one silo to another. With Blockchain it can be transformed into a complete matrix, where each party is included as an equal player with full access to relevant information.

Supply Chain with Blockchain







It doesn't necessarily excludes intermediaries from the equation (at least not immediately), but rather optimizes transactions with them. That provides a framework, which makes supply chain scalable and suitable for modern technology advantages.

Supply chain backed by Blockchain utilizing both smart contracts and cryptocurrency









Fig. 9.1 depicts a more realistic example of supply chain backed by Blockchain utilizing both smart contracts and cryptocurrency. The advantages of this setup are:

- 1. Transparency of performance on past contract sets reputation of players.
- 2. Low barrier for entry for all player in the supply chain enabling disruptive innovation.
- **3.** Smart equipment (eg: self-driving trucks with robotic loading) can automate certain handoff processes that can operate 24x7.
- 4. Faster settlements using cryptocurrencies like Bitcoin.
- 5. Cost efficiency as companies leveraging Blockchain would have a big cost and execution speed advantage compared to the ones that don't use Blockchain.

9.1 Early adopters

IBM alone claims to have over 400 clients who performs Blockchain trials. Companies like Maersk (global leader in containers shipment business) and Walmart (US retail giant) are stepping onto the Blockchain revolution with the first step of replacing a complex paper trail with cheaper, more reliable and scalable solution. As The New York Times <u>reports</u>:





"Maersk had found that a single container could require stamps and approvals from as many as 30 people, including customs, tax officials and health authorities.

While the containers themselves can be loaded on a ship in a matter of minutes, a container can be held up in port for days because a piece of paper goes missing, while the goods inside spoil. The cost of moving and keeping track of all this paperwork often equals the cost of physically moving the container around the world.

What's more, the system is rife with fraud. The valuable bill of lading is often tampered with or copied to let criminals siphon off goods or circulate counterfeit products, leading to billions of dollars in maritime fraud each year."

(Popper,N & Lohr, S. 4 March 2017. Blockchain: A Better Way to Track Pork Chops, Bonds, Bad Peanut Butter?. Web 23 April 2017.

https://www.nytimes.com/2017/03/04/business/dealbook/blockchain-ibm-bitcoin.html

)

9.2 Disruption

We believe the supply chain industry disruption, caused by Blockchain adoption, will roll out in 3 stages:

- 1) Optimization of existing processes by replacement of paper with Blockchain powered solutions, similarly to what Maersk and Walmart are attempting to do, as mentioned above. On that stage early adopters among retail, transportation and warehouse providers will gain competitive advantages due to reducing operational costs and increasing service quality.
- 2) Larger adoption, automation, integration with adjacent technologies: On that stage, we expect changes in the conventional processes by cutting off unnecessary steps, and by reducing the role of intermediaries. Automation in the transactions will remove bottlenecks in product and information flows. Emerging technologies, like smart tags and self-driven trucks will be even more viable. Some segments of supply chain may turn into platform solutions.
- 3) Industry 4.0, shared and distributed manufacturing: A paradigm shift in the goods distribution networks is expected. The powerful intellectual property protection mechanisms provided by Blockchain (specifically smart contracts) will enable concepts like smart factories, composite assembly lines (factory modules installed by different vendors may be located next to each other), and 3D printing for mass market. Instead of shipping finished products, it will be possible





to ship recipies and algorithms while protecting intellectual property. The improved speed, cost, visibility and reliability will likely lead to a production strategy change from predictive to demand-driven. This eliminates inventory issues.

Product/service/ NO information required 12 -12 is structured and well-defined YES Not relevant for blockchain smart Business partner can provide contracts (i.e., NO identity, authorization and advisory services) reputation for the product/ 2 service/information transaction YES Prime candidate for disruptive NO Terms of the transaction can innovation be defined without ambiguity by the participating parties in the transaction YES NO Success of the transaction YES Relevant for blockchain can be easily measured, smart contract observed and verified by the involved parties Figure 4

Determining the applicability of Blockchain (smart contracts) to a transaction

Blockchain Smart Contract Relevancy Decision Chart for Manufacturing

Value Chain Transactions

Figure 9.2

Due to the transactional nature of the supply chain, this process will impact every player in the industry (Fig. 9.3) in one way or another. Some will experience deterioration in their value proposition (visibility and inventory management solutions), some will have to adjust their interfaces (trucking, asset tagging), and others will need to rewrite their models (resource planning, warehousing).

Supply chain industry structure





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Appendix

Links:

General:

Blockchain Technology Beyond Bitcoin (ELPP paper from 2015) Banking Is Only The Start: 27 Big Industries Where Blockchain Could Be Used Ledger Fever: 95 Bitcoin & Blockchain Startups In One Market Map How the blockchain is changing money and business (TED Talk) **Blockchain at Berkeley** 3 Trends Appear in the Gartner Hype Cycle for Emerging Technologies, 2016 Venture Capital Investments in Bitcoin and Blockchain Companies **Blockchain Demo** Blockchain technology: 9 benefits & 7 challenges **Credit Suisse: Eight Barriers To Blockchain Adoption** The 6 Major Hurdles for Blockchain Adoption Block Size Consensus Reached? Bitcoin Classic is Unveiled **Blockchain: Disrupting the Fintech** 99% of Blockchain Startups Are Bullshit IBM Bets The Company On Cloud, AI And Blockchain Can IBM Really Make a Business Out of Blockchain? IBM vs Microsoft: Two Tech Giants, Two Blockchain Visions 12 Bitcoin and Blockchain Thoughts and Quotes You Need to Read "Feds Seize Assets From Mt. Gox's Dwolla Account, Accuse It Of Violating Money **Transfer Regulations":** https://techcrunch.com/2013/05/16/mt-gox-dwolla-account-money-seizure/ https://99bitcoins.com/price-chart-history/

https://dealbook.nytimes.com/2014/01/21/why-bitcoin-matters/

Platform:

Top blockchain infrastructure companies Open source blockchain framework IBM portal about blockchain

Music:

How blockchain can change the music industry Blockchain could completely transform the music industry UJO Music (prospective music industry disruptor) Mycelia (another music licensing disruptor)





dot blockchain music (blockchain powered DRM)

Supply chain:

Provenance (supply chain tracking solution) Skuchain - Blockchain Technology for Collaborative Commerce Can Blockchain Technology UnBlock Supply Chain Management The New York Times article about blockchain adoption 2016 CSCMP report overview Blockchains_smart_contracts_driving_the_next_wave_of_innovation_across_manufacturing_va lue_chain

Main providers

Ethereum - Ethereum is a decentralized platform that runs smart contracts: applications that run exactly as programmed without any possibility of downtime, censorship, fraud or third party interference.

https://www.ethereum.org/

Chain - Chain Core is enterprise-grade blockchain infrastructure that enables organizations to build better financial services from the ground up. Partners: Visa, Nasdaq, Citi, Capital One, Fiserv, State Street, Orange, Mufg https://chain.com/

Factom - We build applications on top of the Factom[™] network that can be used as a public utility. These applications leverage the immutability of the blockchain and the scalability of the Factom[™] network. There is some cost to build custom integrations and a nominal fee per entry into the Factom[™] network. https://factom.com

Dajie - The solution we develop is based on the combination of IoT devices and the blockchain technology. Our IoT devices create a network of nodes in a local Micro-Grid to allow people to exchange energy peer to peer. While the blockchain platform simplifies the management of their transactions. The blockchain, or more in general a distributed cryptographic ledger, is a technology that has been applied so far in the fintech field and allows to record in real time transactions on a distributed database, making them irreversible, safer and more accessible. https://www.dajie.eu/

Peernova - PeerNova has developed a technology platform that provides immutability and data integrity for use in securities exchanges applications. Inspired by blockchain, our patent-pending technology enables use of immutable ledgers and databases in real-time for multi-asset and multi-party transactions. Traditional applications of blockchains involve de-centralized ledgers, distributed consensus protocols, and anonymous users. PeerNova's scalable solution is built for





commercial usage by enabling the same type of data integrity and immutability for financial ledgers without needing to de-centralize the ledger or allowing anonymous users to participate. R3- <u>http://www.r3cev.com/about/</u>

Supporting Infrastructure

Elliptic - We identify illicit activity on the Bitcoin blockchain and provide actionable intelligence to financial institutions and law enforcement agencies. <u>https://www.elliptic.co/</u>

Bitrated - Bitrated builds a layer of trust on top of blockchain technology to bring consumer protection and fraud prevention mechanisms to Bitcoin and other cryptocurrencies. <u>https://www.bitrated.com/</u>

Our goal is to provide cryptocurrencies with tools that enable the market to self-regulate using user reputation, smart contracts and a voluntary (but binding) arbitration process.

Consulting

Neuroware - While the benefits of blockchains are first being felt in finance and commerce, we're building towards a future full of decentralized ideas and applications that have even yet to be conceived, let alone developed. From our base in Malaysia we work globally with developers, startups, and financial institutions by providing tools and infrastructure like Blockstrap, open source applications such as Blockchains.io, and outreach and education at events and hackathons around South East Asia and beyond.

http://neuroware.io/

App Dev

Quantoz - Quantoz offers professional services to explore emerging blockchain technologies and crypto-currencies, and to understand the potential impact for various industries.

Our services are used by financial service companies who are starting to collaborate with specialised FinTech businesses such as Quantoz to complement and strengthen their in-house innovation strategy. A typical use case is how a blockchain can be adopted to process a wide range of financial transactions in a more efficient and cost-effective way.

Quantoz has a passion for building solid software. Our developers have extensive experience and have worked on complex, scalable and mission-critical enterprise applications for large corporate clients. We use Agile methodologies throughout all of the interaction with our clients, from business idea capture through delivery processes to technical implementation.

We know what it is to deliver data-centric and user-friendly solutions which must meet stringent requirements for security, compliance, administration and maintenance.

https://quantoz.com





Infrastructure verticals

Guardtime - The Platform records the state of all KSI-instrumented digital assets by registering them in a global KSI Blockchain, generating a mathematically verifiable baseline image of the network - a *Clean State Proof*. Once this state has been achieved, it becomes possible to continuously verify that the network remains in a the clean state, and act when a compromise is detected.

https://guardtime.com/cybersecurity-platform



