A lead via Blockchain technology

Position paper on a digital Port of Rotterdam

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1.1 Taking a lead via Blockchain technology

Blockchain is perhaps the most promising technology for the Next Economy. The blockchain facilitates complex distributed networks in a transparent manner. It can be the enabler for Internet of Things, big data and algorithms as a service; it can be the backbone for next logistics and circular material chains; it may be the joint neutral broker for decentralized energy; it delivers all sectors new transaction, financing and business models.

But the blockchain is in an early stage. The technology is best known for Bitcoin, a select group of insiders has been tinkering on improved models for years, and now suddenly it is on the agenda everywhere. Blockchain technology has little actual use cases but holds such tremendous promise that around the world, through all sectors, pilot projects and research programs are popping up increasingly.

The Port of Rotterdam has a long history as a leader in logistic innovations and it needs to sustain that forefront role. On blockchain technology it can play a strong hand of cards: the first use cases are being launched; TU Delft department of informatics announces logistics as the dominant area for their blockchain research; the Roadmap Next Economy and the rollout of a field labs ecosystem offer a promising framework; a network of developers, logisticians, shipping companies and financial service providers is eager to start; the Port Authority explicitly chooses to take a lead on this development.

So let's do this, with an urge and with an edge. World players such as Amazon now focus on the digitization of logistics and we need to keep things in our own hands.

1.2 Challenge: schizophrenia within the port

If you want to experience what time travel feels like, you should first visit the APM terminal on the 2nd Maasvlakte, followed immediately by a visit to an SME freight forwarder in the port. It will easily set you back 30 years if not 40. While the terminals such as APMT and ECT have a long history[1] of automation, having implemented innovative solutions such as fully automated cranes, Automatic Guided Vehicles and optimization based on advanced simulation and optimization algorithms over the last 50 years, SME freight forwarders are still very much stuck in the previous century. And it is not only them who struggle. Even big companies, such as Kuehne & Nagel, Maersk and Deutsche Post / DHL Group face challenges when it comes to making the transition towards leveraging the information flows, be it as a result of legacy systems or a botched up implementation of freight forwarding system, that resulted in a €345 Mio. write-off[2]. The Maersk Group, who owns the AP Moller Terminals, through the recently appointed board member Jim Hagemann Snabe, expressed that 'In the next stage, it will be about making the traditional companies more IT savvy and increasing their understanding of the possibilities in digital media'[3].

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[1] This already started in the early 1960, when the first deep sea container terminal on the Maasvlakte was constructed.
[2] http://www.pcworld.com/article/3010156/sap-dont-blame-us-for-dhls-ailing-logistics-system.html
[3] http://shippingwatch.com/people/opinions/article8592744.ece

In the Netherlands, logistics is very much a SME business, with over 28.000 companies employing 250 people or less and only around 100 employing over 250[4]. The metropole region is no exception in that respect. The sector as a whole employs over 400.000 people in the Netherlands, with around 93.000 in the metropole area. The number of people having indirect employment linked to this industry, such as temporary staff hired through temp agencies, infrastructure, professional services etc. is around 83.000[5]. These companies operate warehouses, deliver containers with trucks, barges or trains to these warehouses, provide customs clearance services and take care of the hinterland distribution. These are the companies that have great difficulty developing or adapting to innovations: the education levels of their staffs are low to medium, their margins (hence R&D budgets) are small and under pressure. Very little attention is paid to international standards such as the UN/EDIFACT[6] standard for information exchange and development is very much 'user driven'.

So yes indeed, the port and the logistics sector need to find new ways to innovate, especially in ICT – and these ways should reflect the unique mix of companies active in and around the port in terms of size, activities, sophistication, challenges and (international) focus.

1.3 Dragon boat versus Dinosaurs

Dragon boat? Amazon, after successfully mastering e-commerce, publishing, consumer electronics, supplier and buyer financing, has now turned its attention to logistics. Amazon sees itself as the hub of hubs in the logistics and distribution industries, disintermediating not only shippers like FedEx, UPS and DHL, but thousands of middlemen handling paperwork and cargo associated with transnational trade. Amazon described a 'revolutionary system that will automate the entire international supply chain and eliminate much of the legacy waste associated with document handling and freight booking.'[7] If you assess this move to not be harmful, please have a good look at the sorry state of traditional retail industry…

With things changing at such an alarming rate, just simply keeping up and copying what others are doing, is not very much of a strategy. A faster horse is no longer good enough, we really need to take a quantum leap and develop new business models that leverage 'new' technologies and new market dynamics.

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[4] Kerngegevens MKB 2012/2013 (www.ondernemerschap.nl)
[5] Havenmonitor 2014 (Van der Lugt et al., 2015)
[6] http://www.unece.org/cefact/edifact/welcome.html
[7] http://www.forbes.com/sites/robinlewis/2016/04/01/planes-trains-trucks-and-ships/#356801281408

2. Blockchain Technology

2.1 This could be the one

Blockchain might very well be the game changer we are looking for, as it is both a breakthrough technology and a new paradigm on cooperation, transactions and supply chains. A quote from IBM:

'Blockchain-based shared ledgers can help businesses save time and costs while reducing risks. Additionally, blockchain technologies promise improved transparency among willing participants, automation, ledger customization, and improved trust in record keeping since transactions cannot be altered once validated (by consensus) and written to the ledger.

Blockchain consensus mechanisms provide the benefits of a consolidated, consistent dataset with reduced errors, near-real-time reference data, and the flexibility for participants to change the descriptions of the assets they own.

Because no one participating member owns the source of origin for information contained in the shared ledger, blockchain technologies lead to increased trust and integrity in the flow of transaction information among the participating members.'

Two main assets of blockchain technology hold the promise of really making this desired leap towards a leading role as a digital gateway:
- It is a transparent, resilient and fully automated way to keep track of endlessly complex chains of transactions - commonly found in (international) supply chains
- Blockchain technology enables peer to peer transactions by an open source trust system: cutting out the middle man leads to higher efficiency, but also offers new ways of peer to peer financing and thereby sourcing new capital for growth and innovations.

With these two assets, taking a lead in blockchain technology might very well mean taking a lead in next economy logistics. It is no coincidence that Amazon speaks of this 'revolutionary system that will automate the entire international supply chain and eliminate much of the legacy waste associated with document handling and freight booking'; that powerful international consortia are heavily investing in Blockchain development (see paragraph 2.3); and that especially commodity traders are highly interested.

2.2 Blockchain fundamentals

Before highlighting three key principles of Blockchain technology again a quote from IBM gives away the basics:

'Blockchain is a type of business transaction ledger. A blockchain network is a decentralized system for the exchange of assets. It uses a shared ledger (that is either public or private) for recording the history of electronic business transactions that take place in a peer-to-peer (P2P) business network. A blockchain network may use proof of work, or another consensus mechanism, as a basis of trust, accountability, and transparency, instead of relying on a third-party mediator financial institution or actor.'

Within this complex framework three key principles define blockchain's power to change entire networks, especially in logistics:

- **Build-in trust.** Like in real-life, trust (or reputation) in a bis build up over time. This is supported by cryptography, which allows us to securely encode any piece of data and avoid tampering or ambiguity. This is accomplished through the use of digital signatures, think on-line banking, and hash pointers, which tells us where the value of the previous block was and an encoded digest of that value. Furthermore, distributed consensus allows all the honest members to reach consensus on the content of a block while at the same time ensuring that only honest members are allowed a vote in this.

- **Decentralized and shared ledger**. Although a very important concept, it is by no means unique to the blockchain. Decentralized refers to the lack of a central authority who a) maintains the ledger of transactions b) has the authority over which transactions are valid and c) determine how the rules of the system change. So, with blockchain, there's no longer a need for a dominant member that assumes full authority of the data; instead as the data is shared among the members and a 'consensus version' of the truth emerges.

- **Smart contracts.** Although not specifically mentioned, without smart contracts, the blockchain would just be a pretty nifty way of recording and sharing records in a decentralized database, and it probably wouldn't have created the buzz surrounding blockchain right now. In essence, smart contracts allow us to program on the blockchain to automate transactions. As such, they open the door for 'enterprise-wide' blockchain based solutions.

2.3 International developments

Blockchain is maturing fast. Initial adaptation was very much restricted to 'crypto anarchists', who saw cryptography as a way to achieve freedom and criminals, who saw it as a secure and anonymous way to do business[8]. Bona-fide adaptation of blockchain technology started to take off in 2014; primarily because of extensions to the original blockchain software that allowed programmers to write more sophisticated smart contracts[9]. The financial services industry is very much a frontrunner in the development and actual use of blockchain technology, primarily because of the familiarity with some of the building blocks of blockchain technology, such as cryptography and digital signatures. But other sectors are now moving diving into it as well.

Some relevant examples:

Government. The central bank of the Netherlands is preparing an ambitious experiment aimed at discerning if an entire financial market can be built on a blockchain. This is not about making incremental changes to processes, transactions or business logic, but about creating a whole new financial market infrastructures (FMIs).

Finance. The 42 banks in the R3 REV TLD consortium are working on a private blockchain, after 11 of the banks successfully conducted a test in January 2016. Nasdaq recorded its first securities

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[8] A recent study by the UCL Centre for Blockchain Technologies indicates that recent concerns about the use of bitcoins for illegal transactions might be overstated and that these types of transactions could further diminish as the blockcain and bitcoin technology will become more mature.

[9] http://www.economist.com/news/briefing/21677228-technology-behind-bitcoin-lets-people-who-do-not-know-or-trust-each-other-build-dependable

transaction on its blockchain-powered Linq exchange in December 2015. The technology could cut $20 billion in annual costs in global banking according to a Santander InnoVentures analysis[10].

Insurance. Allianz, a German insurer, is working with startup Everledger to develop a blockchain to track diamonds from mine to retail sale. For each diamond, Everledger measures 40 attributes: cut and clarity, the number of degrees in pavilion angles and, eventually, where they were mined. The company generates a serial number for each diamond, inscribed microscopically, then added to Everledger's blockchain.

Health. MIT is building a blockchain to let individuals store personal data securely, and selectively issue permission for its use. For example, individuals could select portions of personal data to release to doctors for treatment or drug researchers to study[11]. This opens the door for personalized data to be traded by individuals in exchange for crypto-currency such as Bitcoin, just like any other commodity.

Energy. Residents of Perth who generate electricity using roof-top solar panels and have excess energy can sell this directly to their neighbours using a blockchain-based solution. Not only does it keep track of who generated the electricity, but it also manages multiple trading agreements between consumers who buy excess solar direct from the original owner or producer. The owners of excess energy can sell their surplus to their neighbors for less than the uniform tariff but more than they would get from selling it to their retailer and by doing this, effectively cutting out the middle-man.

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[10] http://santanderinnoventures.com/wp-content/uploads/2015/06/The-Fintech-2-0-Paper.pdf
[11] http://blogs.wsj.com/cio/2016/02/02/blockchain-catalyst-for-massive-change-across-industries/

3. Blockchain meets port logistics

3.1 Blockchain and port logistics

Although actual implementations of blockchain technology have been limited up to now, the technology offers considerable potential to change the way we manage supply chains. Conceptually, they revolve around the following themes:

- **Increased Compliance and Transparency** – Transparency is the most influential and important benefit of blockchains[12]. Blockchains will help to prevent organizational silos within existing parts of the supply chain. Instead of having data buried in legacy data traps, such as ERP or TMS systems or the highly centralized data prisons of information brokers, it is now available in a distributed and decentralized way for all supply chain members in a secure way. For example, Tradecloud (www.tradecloud.nl) uses blockchain technology to provide their customers with increased supply chain transparency.

- **Better Tracking of Orders and Assets** – Since blockchains can be effectively tracked through all processes, companies using blockchain technology will be able to more readily produce detailed information about a product's lifecycle, including supplier information, manufacturing details and logistics information. A good example of this is the luxury good use-case as described in paragraph. Concerning tracking and tracing of goods on the move a very interesting project is the one that is about to start in a number of ports in Finland, Estonia, Latvia and Sweden and involves LSP's fitting out containers with active trackers that will not only provide information about the whereabouts of the cargo, but also about the conditions in which it is being transported and its ambient temperature[13]. The EU is subsidizing this project[14].

- **Resolve trust issues** – Trust issues are an integral part of any (international) supply chain and are the 'raison d'étre' for Bill-of-Ladings, Letters-of-Credit, middlemen such as a freight forwarder or a bank, severely complicating processes that at first glance appear to be simple, such as the release of a container. What would happen if we could run a supply chain on a system that has built in trust? Just like in the world of banking, this potentially would lead to billions of dollars (or Bitcoins) in savings, and could result in a big push in international trade. Skuchain (www.skuchain.com) is one of those companies that has stepped into this market and offers a blockchain based collaborative commerce platform that allows buyers and sellers to securely transfer documents and ownership, based on self-executing smart and legally binding contracts.

In this chapter we will discuss a number of blockchain related developments that have a strong link with port logistics and supply chains in more detail. These initiatives are part of projects that are currently being pursued in the Netherlands in the field of logistics and blockchain technology and are in various stages of development, from ideation to proof-of-concept development. These examples do not only illustrate the potential blockchain technology has for the field of (port) logistics and supply chain and how it interacts with other technological concepts, such as Internet of Things and Big Data, but also show how these combinations can lead to new business models based on the principles of the Third Industrial Revolution (Rifkin, 2011). Last, but not least it should serve as inspiration for additional implementations of blockchain technology in the (port) logistics and supply chain domain.

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[12] http://cerasis.com/2016/06/29/blockchain-technology/
[13] http://www.bloomberg.com/news/articles/2016-05-19/built-for-bitcoin-blockchain-goes-beyond-crypto-currency
[14] http://www.coindesk.com/finnish-city-wins-2-4m-blockchain-shipping/

3.2 Cross chain collaborations

An efficient and effective flow of data within the supply chain is vital to achieve responsiveness to customer demand and overall customer satisfaction (Singh 1996). Other research (for example Simchi-Levi 2007, Lee 2000, Stank 1999) has shown that a supply chain that implements coordination is characterized by effective communication and information exchange[15]. And despite technological advances, such as XML[16] and API's[17] and the coming of age of logistics information brokers such as Descartes (https://www.descartes.com/), Seeburger (www.seeburger,eu) and Portbase (www.portbase.nl), sharing of information between supply chain members active is still very much a cumbersome process with many organizations managing the same order, but the data is redundant and inaccurate (de Kok et al. 2014). This is particularly true when the supply chain is decentralized, with numerous transactions between members (freight forwarders, customs, terminals, warehouses, road transport companies etc.) and the information is stored in a wide variety of systems, such as TMS[18], WMS[19], CMS[20] and ERP[21] systems as is the case with the activities in and around the port of Rotterdam and its hinterland.

Blockchain could provide a way out of this Minotaur Labyrinth of systems and one-off and tailor-made connections.

The virtual eco-system
The 'virtual eco-system' as described in De Kok et al. 2014 is a system that supports cross-chain collaboration in the transportation of containers, or any packaging unit for that matter, such as cartons, IBC's, cases and trollies and products.
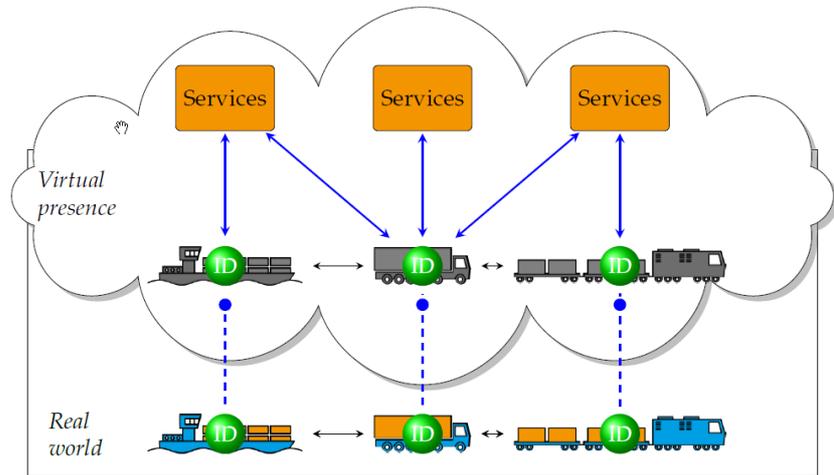See *Figure 1*.

Figure 1 The virtual eco-system

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[15] Although data and information historically have had a very different meaning they are used more and more interchangeably in research papers and articles, as the line between them is becoming more and more blurred with the onset of fully automated Big Data and Artificial Intelligence solutions. However, strictly speaking information processing is a skill only possessed by human beings and not machines, at least upto now.

[16] XML is short for Extensible Markup Language and is a markup language that defines a set of rules for encoding documents in a format that is both human-readable and machine-readable. (Wikipedia)

[17] API is short for Application Programming Interface and Just as a graphical user interface makes it easier for people to use programs, application programming interfaces make it easier for developers to use certain technologies in building applications. By abstracting the underlying implementation and only exposing objects or actions the developer needs, an API reduces the cognitive load on a programmer. (Wikipedia)

[18] TMS stands for Transport Management System. This system is used to plan and transport, be it with own assets, such as trucks and barges, or assets from other transport companies.

[19] CMS stands for Customs Management System. This system is used to plan and control the clearing of goods and handles the communication with customs.

[20] WMS stands for Warehousing Management System. This system is used to plan and control warehousing operations, including activities such as picking and packing of items, planning of warehouse resources, allocation of items to storage locations.

[21] ERP stands for Enterprise Resource Planning System is a category of business-management software—typically a suite of integrated applications—that an organization can use to collect, store, manage and interpret data from many business activities such as finance, procurement, sales and manufacturing.

Each container creates a digital shadow of itself that virtually categorizes relevant information. This virtual container uses an electronic dossier, stored on a blockchain, which contains the characteristics of the load, the location, shipping conditions, such as humidity and temperature and the specific shipping instructions of the cargo. Encrypted data is being pushed to authorized supply chain partners, depending on their access rights in the dossier or certain parts of the dossier, based on smart contracts, upon changes in the electronic dossier. Companies have now the ability of sharing crucial information through the ecosystem, which can be used to make better decisions in optimizing the supply chain. For example, when it comes to truck utilization and CO_2 reduction across organizational boundaries.

How could this work in practice? Before dispatch from a Container Freight Station (CFS) or shipper's own warehouse in Shanghai to the terminal in Shanghai the container receives a Marvin[22] transponder. This is a Raspberry-Pi-like computer with a long range Wi-Fi transponder build on top. It will not only be able to store data, such as GPS coordinates or the temperature inside of a container, but also process it and share it with other nodes on the blockchain. The data stored in the transponders in itself are part of the distributed data set on the blockchain. The Fraunhof institute in Germany has already started work on such a container[23].

The concept is also being considered as a possible implementation path to establish a Smart Logistics Hub blue print for the fresh produce supply chain in the Metropole Region Rotterdam the Hague. This research is being done on behalf of the municipality of Rotterdam by Roos + Bijl (www.roosenbijl.nl) and BeSCOPE Solutions[24].

3.3 Supply chain finance

Steeman (2014) defines Supply Chain Finance (SCF) as 'Financial arrangements used in collaboration by at least two supply chain partners and facilitated by the focal company with the aim of improving the overall performance and mitigating the overall risks of the supply chain.' Blockchain technology opens up new ways for financial institutions, LSPs, shippers and receivers to work together in new innovative business models based on shared information, trust, smart contracts and low transaction costs.

Post shipment financing
The virtual eco system in combination with blockchain technology is currently being piloted by a consortium of ABN-AMRO, TransFollow[25] and TKI Dinalog[26]. TransFollow developed an app for use on smartphones and tablets to replace the paper consignment note. Upon signing of for receipt of the cargo at the delivery address, the data from the digital consignment note is made available on the blockchain and triggers direct payment of the freight invoice based on a smart contract.

In-transit financing
Blockchain ledgers can offer a way of providing a shared information position about inventory being held at a LSP warehouse in a far more trustworthy way than existing systems. Depending on the used technology and/or configuration, contents of a blockchain can be considered undisputed. Especially when transactions of goods between parties are registered in an unrepudiable manner through a

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[22] Marvin is being developed by the IoT Acadamy based on the RDM Campus in Rotterdam.
[23] http://www.iis.fraunhofer.de/en/ff/kom/proj/smarttracking.html
[24] BeSCOPE Solutions is a SCM consultancy and interim management firm. See www.bescope.eu.
[25] Transfollow (www.transfollow.nl) developed a digital consignment note that can be signed-off on a smartphone. It is an initiative of both the Dutch Transport Industry Association (TLN) and the Dutch Shippers Industry Association (EVO).
[26] TKI Dinalog (www.dinalog.nl) is the cooperation within which Dinalog, TNO and NWO act jointly to boost innovation in logistics.

blockchain, a finance institution could almost automatically consider the goods for financing. In other words, blockchain concepts could make financing of inventory for especially SMEs practical, scalable and profitable. If so, billions of working capital could be released from its dead state. Furthermore, as a result of having more secure assets, the financing party is willing to increase the percentage of the inventory being financed. It also forges a long-term relationship, currently not existing, between LSP and their clients, making the LSP less vulnerable to the 'race to the bottom' that is simply the case nowadays for LSP's as a result of the competitive environment and the yearly tender. This use case is currently being piloted by a consortium of ABN-AMRO Commercial Finance, NBK[27], BeSCOPE Solutions and TKI Dinalog[28].

3.4 Track & trace of agricultural chemicals

For more than a decade, regulators, industry and formers in numerous countries have been struggling with the growing market in illicit agro-chemicals and plant protection products (PPP)[29]. It is estimated that about 10% of the EU pesticides market is comprised of illegal pesticides, representing a value of around USD 1 billion (Moss 2013). With the global market for legitimate pesticides being estimated at around USD 60 billion, it should come as no surprise that it has attracted considerable criminal interest. As illicit pesticides pose potentially serious threats to human safety and health, economies, businesses and farmers, the environment and national security effective enforcement of health and safety laws and regulations concerning the use and sale of pesticides is of great importance. The single biggest risk lies in the re- and uplabeling of finished products once they are in the distribution and point of sale channels. Creating a closed-loop supply chain, similar to the EMCS[30] system used for excise goods in the EU with designated loading and unloading locations, supported by a blockchain solution similar to the one described in paragraph 0 for the luxury good industry would reduce this risk considerably.

3.5 Enabling the circular economy

Use of new technology and the circular economy are two of the mainstays of the Third Industrial Revolution. Luckily we have a number of companies in the Rotterdam port area that are already active in the circular economy, such as Inashco, capable of extracting valuable raw materials from all kinds of waste. In turn, these raw materials can be converted into finished products, using modern production technology such as 3D-printing or micro-factories. Data about these finished products and their constituting components/resources would become a Bill-of-Material for a new finished product upon the original product reaching its end-of-life. With such a closed-loop system in place, one could also make better estimations of expected reverse flows, guarantee the circular credentials of products, more easily connect sellers of end-of-use goods and buyers of resources present in these goods and further optimize supply chains in general by stabilizing producer's sourcing positions. Given the possible characteristics of blockchains in the sense of transparency, immutability, traceability and scalability, it is logical to explore its possibilities within reverse logistics and a more circular economy.

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[27] NBK is a SME LSP founded in 1919 and specialized in chemical and excise logistics.
[28] TKI Dinalog (www.dinalog.nl) is the cooperation within which Dinalog, TNO and NWO act jointly to boost innovation in logistics.
[29] http://www.unicri.it/in_focus/files/The_problem_of_illicit_pesticides_low_res1.pdf
[30] The Excise Movement and Control System is a computerized system specifically designed for the monitoring of excise goods under duty suspension in the EU.

3.6 Further research areas

Complementary to these four lines of promising Blockchain applications, some research areas deserve R&D power too:

Data exchange in the blockchain age
Since the 60s of the previous century a lot of effort has been put in getting computerized systems to share data with each other. An obvious solution for that was standardization, both industry specific and general – like the UN/EDIFACT standard and more recently the UETP) standard[31]. Although useful, fundamentally they are still based on the concepts of data exchange from the previous century. What we need is a way to exchange data between systems that suits the blockchain age and is no longer based on mapping field data from one relational database into another.

The holy grail of supply chain management
Careful analysis of successful applications in supply chain management shows that they are based on managing the supply chain as a single entity as a result of one dominant member being able to impose his will on the others. However decentralized supply chains do not have such a dominant member and as a result the potential benefits of supply chain management have so far been much more difficult to realize in these systems. However, using smart contracts in combination with new advanced planning algorithms the (dis)benefits could be fairly distributed among the supply chain members based on actual and immutable transactions.

Shared services operating system
Picking up a container, unloading a truck in a CFS, stuffing an export container, sending an invoice to a client, booking an incoming invoice, custom clearance; hardly stuff to get excited about. Your next door competitor does exactly the same and the only way you can differentiate yourself is by being cheaper. The end result: 'a race to the bottom'. What if we would develop a shared system for all these kind of 'non-unique selling point' type of activities? One in which all trust issues are resolved and automated? One in which all processes have been redesigned, made simpler or even totally obliterated? This would significantly lower the transaction costs in and around the port of Rotterdam, making it more competitive -increasing volumes and efficiency and allowing LSPs to compete on value-added, not on price. Science fiction? Perhaps, but in the Kouvola[32] region in Finland a pilot has started with the aim of doing just that. Granted, this initiative will not go down well with a lot of members in the port community, but isn't it better to be master of your own destiny than having to rely on Mr. Bezos?

Cross overs with other digital innovations
Nothing can survive in a vacuum and as interesting as blockchain may be, it requires other technologies and concepts in order to come really into its own and shine: .

- **Internet of Things**
  It is easy to see that both blockchain and Internet of things (IoT) rely on a decentralized and distributed structure, making them a match made in heaven from an IT architecture point-of-view. A good example of this 'marriage' is the virtual eco system as described in paragraph 0, where a sensor bolted on a container acts as a node of the blockchain and contains data about the location and condition of the container.

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[31] http://www.focafet.org/uetp.php
[32] http://www.bloomberg.com/news/articles/2016-05-19/built-for-bitcoin-blockchain-goes-beyond-crypto-currency

- **Big Data**
  For many applications, the speed of data creation is even more important than volume. (Nearly) real-time makes it possible for a company to be much more agile than its competitors. The structured databases that stored most corporate information until recently are ill suited to storing and processing big data, because of its highly distributed and decentralized character. This is where blockchain comes into play.

- **Algorithms as a Service**
  Conceptually, Algorithms as a Service (AaaS) provide a model for distributing, operating and monetizing algorithms that can be used from third party applications. Instead of having to buy a whole APS suite it is now possible to just select the algorithms you need, lowering the financial hurdle and giving SME companies easier access to these advanced capabilities.

- **Infrastructure (fibre) / LoRa Wifi**
  In 2015 a pilot started, offering high-speed connectivity to companies located in the Merwehaven-4 harbour. Reactions have been very favorable and it has made the area a more attractive location for business. If we are serious about developing innovative new services and really make this transition towards a digital port, investment is needed in so-called *neutral networks*, where any ACM[33] registered service provider is free to offer his services to the end-user.

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[33] ACM stands for Autoriteit Consument & Markt, the Dutch anti-trust and consumer interest watchdog

4. Taking the leap

4.1 Rotterdam reality

Having focused on new possibilities in the last two chapters, let's get back to the Rotterdam port reality.

At the moment the connectedness is not functioning like it should. Within maritime data networks and flows, it is observed that data provided by inland shipping work at a different pace with data produced on a daily basis instead of real-time. The processes in the container system at the moment are not functioning in a smooth flow: during the handling of the containers, the performance is measured in minutes but when the container has been moved to the stack it may be stored for several days. The business models at the moment are not based on transparent chains and sub-optimized.

The organization of the physical processes in container chains is highly developed. What is lacking is an integrated approach towards managing all aspects of the supply chain, i.e. coordination of the physical, financial and information flows. It is very difficult to realize this type of crossovers in the port of Rotterdam because the big firms in the port and in particular the Port of Rotterdam Authority are seen as 'unapproachable bastions' for SME's or startups.

In order to take a leap towards a leading role as a digital gateway we will have to close the gap between the situation at hand and the data driven new perspectives. The most urgent challenges are:

1. Development of relevant skills and expertise, needed to develop, adopt and/or implement blockchain solutions;
2. New models to involve SME's, who can particularly benefit from decentralized data systems but at the same time are our port laggards;
3. Research and experiments on the most promising blockchain applications, as described in chapter 3;
4. Tapping into an international network of blockchain experts, projects and showcases, as this an early stage innovation and we need every best practices and insight available.

There is no reason to be pessimistic – a lot of ingredients are at hand. First of all, the last half year has seen an almost exponential interest in. There's a sense of urgency to do 'something' with blockchain. Hype? Perhaps, but you cannot start a fire without a spark. Furthermore, the MRDH region has a long history when it comes to maritime innovation; it is in our DNA, just like building dams and being extremely direct. Pioneering companies, both large and small have teamed up with regional knowledge partners like TU Delft and Dinalog and are working on pilots like the ones mentioned in chapter 3. We are at first base.

In this early stage of blockchain development, bundling forces and formulating a joint focus and urge, might very well ignite a big leap forward. This would require a model acknowledging all work already done by entrepreneurs and researchers, facilitating easy exchange of cases and expertise and making serious investments in new research and experiments. Blockchain experiments now depend on a small selection of professionals – there is not yet a strategic and fundamental backbone. A Blockchain fieldlab, focused on port logistics, would help both those who already started and all port partners who now witness a large gap between their shop-floor realities and tempting stories in the media.

4.2 The Dutch Approach

The Dutch approach towards the use of blockchain in the field of logistics closely matches the decentralized character and distributed consensus of the blockchain itself. Instead of doing it alone, or in combination with a big-5 consulting firm, a 'coalition of the willing' was formed that includes government, business and knowledge institutions, both large and small. Furthermore, the idea of a proprietary blockchain is considered to be something of an oxymoron, hence the choice for open-source software and a heavy emphasis on knowledge sharing and co-creation. The main challenge when implementing new technologies is not the lack of ideas, but the need to work with both a 360 view and a highly diversified range of practices. We think that thanks to the diversity of the coalition involved this can be accomplished and that we might have a pole position for a revolutionary breakthrough in blockchain technology. And indeed this advantage is also more and more being recognized abroad.

4.3 The Blockchain Fieldlab

The concept
A *Blockchain Fieldlab* indeed is the obvious choice to start working on the agenda mentioned above. In fact, most partners needed to start it up, are already involved in writing this paper or realizing the pilot projects from chapter 3. The fieldlab, second base, is at hand.

Fieldlabs are practice environments for companies and research institutes, established in order to develop, test and implement *smart industry* solutions. They combine R&D with capacity building and function as network nodes instigating new cross over projects. Most Fieldlabs start with public funding and attract private investments on both a strategic and on a project level. A Blockchain Fieldlab will be welcomed in an proactive regional ecosystem that is supported by a.o. the MRDH and Innovation Quarter – other Fieldlabs include a Big Data Innovation hub and an Additive Manufacturing Facility. The Ministry of Economic Affairs, through the Blockchain Core Competence Center (B3C) initiative, is a strong supporter of blockchain technology and rates it as one of the most disruptive innovations since the internet. It propagates logistics as one of the areas where blockchain could have the biggest impact. The B3C is to provide active support for fieldlabs and co-creation and provides possibilities for co-funding.

Lines of research
The Blockchain Fieldlab will focus on the following lines of research:
- ideation – creative search for new applications business models and inverse infrastructures[34];
- pilots and prototyping on (new) blockchain applications in logistics and finance (others, energy?), building on the working lines from chapter three;
- elaborate market research: innovation needs, domain specific 'blockchain readiness' and other relevant specifics amongst both SME's and larger players;
- international expertise: new insights and state of the art updates, best practices, developments in other world player ports;
- integrator: exploring crossovers between blockchain and other emerging technologies, IoT, big data and algorithms as a service in particular.

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[34] Inverse Infrastructures, disrupting networks from below (Egyedi, Manos, TU Delft, 2012) –
https://books.google.nl/books?id=wG4c7s8uKjUC&lpg=PP1&hl=nl&pg=PR14#v=onepage&q&f=false

Other services

Next to research the Blockchain Fieldlab will provide:

- skill development, training and a establishing a community of practice for port (related) professionals;
- involving students (medium and higher vocational education) in learning by doing programs;
- a partner role for both port strategy and relevant innovation programs;
- development of low threshold starter kits, needed to involve SME's. Think of a physical prototype that helps explaining the guiding principles; plug and play modules to experience the blockchains productivity; quick scans that help identifying application possibilities.

Partners

As mentioned before: partners are lined up. Our forefront already involves the Port Authority, the City of Rotterdam, Dinalog, TU Delft, BeSCOPE Solutions, Studio Wolfpack and a network of independent (blockchain) pioneers, Ritra and NBK. Other partners are about to join: for instance shipping companies, other LSP's, banks (ABN AMRO already is a partner in several use cases), Innopay and shippers. The aim is to get all the roles on-board that are actively involved within (international) supply chains.

0900-Blockchain

0900-Blockchain is the working title for a commercial counterpart of the fieldlab that offers support on blockchain related innovations to companies and commercially viable projects or programs. While the fieldlab focuses on the port ecosystem, 0900 delivers company specific consulting and development.

By sharing staff the fieldlab and 0900 can build a joined base of expertise, provide the port companies with state of the art knowledge via 0900 and at the same time sharpen the fieldlab program with real time shop-floor feedback. In this partnership the fieldlab (foundation) will hold shares in the 0900 venture, valuing the knowledge and innovations it brings to the table and generating new research budgets.