

Master Thesis - Project Plan

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The following project plan is meant for coordinators around the project to be informed about the general direction of the master thesis project. The current state of the documentation is that of a draft.

1 Host Organisation

Collaboration got initiated between Dylan Bartels and Hjalmar van der Schaaf during the UvA 2017 thesis fair. CargoLedger is located in the ACE Incubator of the University of Amsterdam. More information regarding CargoLedger can be found on: www.cargoledger.nl

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2 Project Summary

Cargoledger wants to know how a trustless decentralized peer-to-peer marketplace could support the supply chain. They recently developed the technique of broadcasting smart contracts, representing supply chain goods, on the Ethereum network[?]. With this foundation they are aiming to create a marketplace for logistical smart contracts. On this marketplace different actors can broadcast, contribute or fulfill these smart contracts, whereby the smart contract is defined as a request of transport of goods along the supply chain.

To put this project into the global context, the values of the project align with reducing centralization, advance transparency and achieving sustainability. Research in the direction could achieve the academic information to build a marketplace whereby individuals can benefit from transporting goods on their everyday transport route. Current transport of goods is done by central entities being a custodian for the transport and bulking the goods from central drop-off points to sorting centers to the actual endpoint. If this transport is open to the public in a peer-to-peer manner the positive benefits can be efficiency and equal opportunities for different size actors.

Recent successful technical innovations have been due to a shift from centralization to peer-to-peer services, examples of these are Uber, Airbnb and Kickstarter. In the domain of supply chain logistics this innovation has been lacking. Recent research [?] have proposed a peer-to-peer framework supporting interoperability between different actors in the logistics chains. This research lacks insight related to trust, network and technical implementation but establishes interest in the domain regarding implementation.

With the recent progression in the domain of trustless value transference, research towards the applicability of this in the supply chain offers relevancy. In [?] research has formulated possible implementation of trustless intermediation in blockchain based decentralized service marketplaces. The research topic arises if this or other intermediation solutions can also be applied to peer-to-peer logistics marketplaces and to which degree will there be a custodian in the process due to it including a physical process.

Main research question:

- What are the specific problems and characteristics of a trustless decentralized peer-to-peer marketplace for transportation of goods?

Subquestions:

For the following subquestions marketplace is defined as a trustless decentralized peer-to-peer marketplace for transportation of goods.

- Can trustless intermediation exists on this marketplace without a custodian for dispute prevention and resolution?
- What level of anonymity is possible on this marketplace?

3 Problem analysis

Cargoledger has been working to integrate the possibility of decentralization throughout the supply chain, what they have not researched is how to connect the demand and supply of the transport. The problem of connecting these two parties is of high importance to open up the supply chain to peer-to-peer possibilities. Research into what the problems and characteristics of such a marketplace are would possibly open the way to such a marketplace and align it with the other product in the company so that a pilot of the full system can be initiated.

Peer-to-peer computing [?] has lead the way for many different applications. Marketplaces have been a domain of research along academia of applying this architecture. In [?] Ferreira & Ferreira, 2004 discuss the implementation of essential services for peer-to-peer marketplaces and illustrate its benefits for a vendor. Recent study [?][?] has contributed to an distributed permission system, called Dispersy, which simplifies the design of distributed communities. Researchers are able to take this foundation and bootstrap distributed communities and expand it to other domains.

A well established peer-to-peer marketplace is Openbazaar. This open-source project has been created in 2014 and has contributed to academic research in the domain[?]. Openbazaar uses a shared protocol architecture layer which makes it possible to use the peer-to-peer data layer as a foundation to build marketplace services on. Openbazaar uses a Kademlia-style peer-to-peer network with Ricardian contracts.

Trust on peer-to-peer marketplaces have been widely researched [?][?][?]. These researches establish different ways to achieve trust whereby no intermediate entity is needed to reach the goal. These implementations are not meant to be applied to logistics but do offer perspective on how trust is achieved in other domains.

For a more detailed description of literature used see chapter 9.

4 Research method

Reasons that will make the research difficult:

- The crossover of trustless intermediation between the digital and physical domain.
- Minimal peer review on academical published trustless remittance (blockchain domain).

- Academic research related to anonymity requires a high degree of math.

The chosen research method will be action research methodology. Action research can be defined as an approach in which the action researcher and a client collaborate in the diagnosis of the problem and in the development of a solution based on the diagnosis. With this method a prototype of the marketplace will be build in collaboration with Cargoledger. The methodology has the downside that biases might occur towards the chosen solution due to also being responsible for the development.

The input from the literature survey will give all the components which altogether make the concept provable to a certain degree. Currently it has given the distributed permission system on which the orderbook of contracts of the marketplace will take place. The remittance of the contract will take place on a remittance layer which, given the trustless focus, will be a blockchain solution. The referenced literature does not go in further detail which specific blockchain solution but uses a modular approach taking the core principles and keeping the implementation open for preference.

The proof of concept which will be made is a concept of the peer-to-peer marketplace build upon existing technology of <https://github.com/Tribler/dispersy> or <https://github.com/openbazaar> as peer-to-peer message layer.

5 Expected results

The following results are expected from the project:

- Problems and characteristics of the marketplace
- Framework to incentive all the actors accordingly
- A proven achievable degree of anonymity

Academic research and open source projects will be the source of information used for the research project. Different proven open source project are useful for modular aspects of the marketplace and will be referenced to accordingly. The documentation of the research will take place on www.sharelatex.com in collaboration with the appointed supervisor and Cargoledger collaborators.

During the research a prototype of the marketplace will be developed. This prototype will be the testing ground to discover the problems and characteristics of the marketplace.

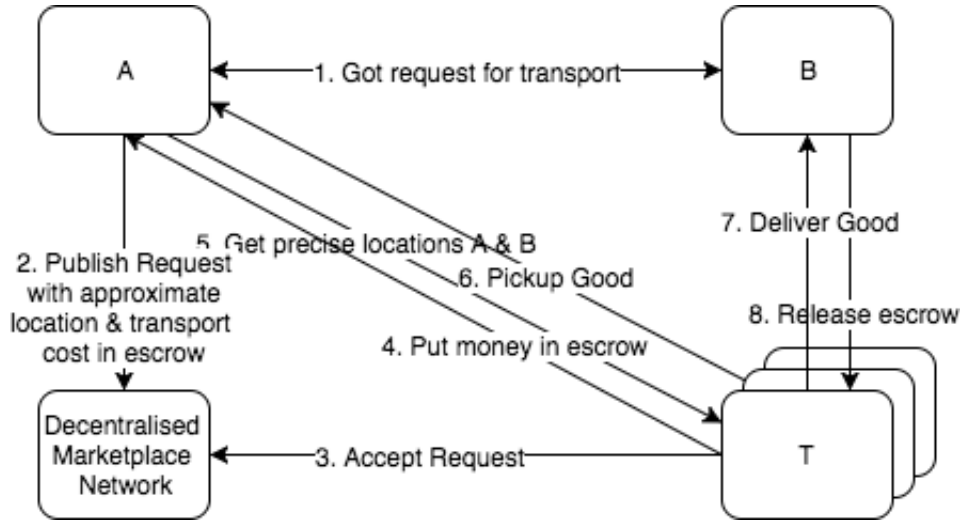


Figure 1: Expected characteristic for intermediation

The current hypothesis for the biggest weighing problem and characteristic is the following:

Total trustless intermediation will not be possible in the marketplace due to there always being a custodian responsible for the physical transport.

Figure 1 represents a prediction on how the intermediation will likely occur. The escrow aspect will likely be a logical construction containing 3/3 multi signature [?] signing whereby the escrow will be released upon delivery and B signing.

6 Required expertise

Languages

- Python
- Solidity
- Go

Main

- Make

- Git
- Dispersy (<https://github.com/Tribler/dispersy> message layer)
- PyQT (<https://riverbankcomputing.com/software/pyqt/intro>)
- NoseTest (<http://nose.readthedocs.io/en/latest/>)
- Package manager (pip)
- Yaml
- Docker
- IPFS
- Multi Signature
- Ricardian Contracts

7 Timeline

Timeline elements

- Bootstrap dispersy/openbazaar
- Adjust bootstrapped platform shared protocol layer
- Create trustless intermediation logic
- Implement trustless intermediation
- Improve privacy
- Front-end

8 Risks

Assumptions to be taken beforehand:

- Rational behaviour of actors

Limitations:

- Transaction/conformation time blockchain
- What if end point is not available to receive transport?

9 Literature survey

9.1 Trustless Intermediation in Blockchain-based Decentralized Service Marketplaces, 2017 [?]

Summary: Service marketplaces promise an open platform for sellers and buyers of IT services. The marketplace design usually assumes that market functions, such as match-making, transaction settlement, and dispute resolution are performed by intermediaries in a centralized system. We propose the concept of trustless intermediation to enable new forms of decentralized service marketplaces. By leveraging blockchain-enabled smart contracts we eliminate the need for trust in marketplace intermediaries and reduce barriers of entry, lock-in, and transaction costs, by removing now obsolete trust-establishing mechanisms. Desema, our decentralized service marketplace prototype, is a first implementation of this concept that is based on the Ethereum blockchain in combination with IPFS, a peer-to-peer distributed file system.

Differ from my approach: Klems et al., 2017 researched is towards trustless intermediation in decentralized service marketplaces whereby my research is aimed towards physical execution of transport. Due to it being in the physical domain other ways of making the process trustless need to be researched.

Obtained result: Klems et al., 2017 created a prototype marketplace named Desema where they applied their trustless system architecture.

Remaining open questions: Open challenges include the design and development of more advanced and incentive-aligned approaches for trustless dispute resolution between service providers and consumers.

9.2 Beaver: A Decentralized Anonymous Marketplace with Secure Reputation, 2016 [?]

Summary: Amid growing concerns of government surveillance and corporate data sharing, web users increasingly demand tools for preserving their privacy without placing trust in a third party. Unfortunately, existing centralized reputation systems need to be trusted for either privacy, correctness, or both. Existing decentralized approaches, on the other hand, are either vulnerable to Sybil attacks, present inconsistent views of the network, or leak critical information about the actions of their users. In this paper, we present Beaver, a decentralized anonymous marketplace that is resistant against Sybil attacks on vendor reputation, while preserving user anonymity. Beaver allows its participants to enjoy open enrollment, and provides every

user with the same global view of the reputation of other users through public ledger based consensus. Various cryptographic primitives allow Beaver to offer high levels of usability and practicality, along with strong anonymity guarantees. Operations such as creating a listing, purchasing an item, and leaving feedback take just milliseconds to compute and require generating just a few kilobytes of state while often constructing convenient anonymity sets of hundreds of transactions.

Differ from my approach: Soska et al., 2016 offer an fully anonymous decentralized marketplace that is resistant against sybil attacks by leveraging costs against these actions. The reputation is actually registered on a blockchain which differs from my approach which does not aim for full anonymity and a mandatory registering of reputation in the blockchain.

Obtained result: Soska et al., 2016 presented a decentralized anonymous marketplace with a incentive structure which counteracts the cost of Sybil attacks.

Remaining open questions: Vendor privacy related to all transactions being anonymously stored on the blockchain, so the quantity of vendor transactions can be known. Unclaimed reviewing fees when customers do not follow the incentive structure. Customers deanonymizing themselves. Collusion attacks. Values of fees.

9.3 Building Trust in Decentralized Peer-to-Peer Electronic Communities, 2003 [?]

Summary: Many players in electronic markets have to cope with much higher amount of uncertainty as to quality and reliability of the products they buy and the information they obtain from other peers in the respective online business communities. One way to address this uncertainty problem is to use information such as feedbacks about past experiences to help making recommendation and judgment on product quality and information reliability. This paper presents PeerTrust, a simple yet effective reputation-based trust mechanism for quantifying and comparing the trustworthiness of peers in a decentralized peer-to-peer electronic marketplace. There are three main contributions in this paper. First, we argue that the trust models based solely on feedbacks from other peers in the community is inaccurate and ineffective. We introduce three basic trust parameters in computing trust within an electronic community. In addition to feedbacks in terms of amount of satisfaction, we incorporate the feedback context such as the total number of transactions and the credibility of the feedback sources into

the PeerTrust model for evaluating the trustworthiness of peers. Second, we develop a basic trust metric that combines the three critical parameters to compare and quantify the trustworthiness of peers. Third, we present a concrete method to validate the proposed trust model and report the set of initial experiments, showing the feasibility, costs, and benefits of our approach.

Differ from my approach: Xiong & Liu, 2003 focus on the wide domain of trust in decentralized peer-to-peer communities. With my specific case regarding a marketplace with transport of goods trust between the peers is an important aspect but is more contained in a specific domain than Xiong & Liu.

Obtained result: Xiong & Liu, 2003 present PeerTrust a trust mechanism for building trust in peer-to-peer electronic communities. They identified three important trust parameters, these are: amount of satisfaction, number of interactions and balance factor of trust. They put the results into experiments which demonstrated the effectiveness, costs, and benefits of the approach.

Remaining open questions: Looking at ways to make the approach more robust against malicious behaviors, such as collusions among peers. Combining trust management with intrusion detection to address concerns of sudden and malicious attacks. How to uniquely identify peers over time and associate their histories with them

9.4 Reputation Systems for Anonymous Networks, 2008 [?]

Summary: We present a reputation scheme for a pseudonymous peer-to-peer (P2P) system in an anonymous network. Misbehavior is one of the biggest problems in pseudonymous P2P systems, where there is little incentive for proper behavior. In our scheme, using ecash for reputation points, the reputation of each user is closely related to his real identity rather than to his current pseudonym. Thus, our scheme allows an honest user to switch to a new pseudonym keeping his good reputation, while hindering a malicious user from erasing his trail of evil deeds with a new pseudonym.

Differ from my approach: The reputation system is organized through a central entity called bank which is responsible for the reputation value exchange by the means of coins. This centralizes the reputation system which differs from my approach.

Obtained result: The first contribution is defining security for identity bound reputation systems. The second contribution is the construction of

a reputation scheme that satisfies the security definition.

Remaining open questions: First, the scheme uses unit coins for reputation whereby the coins have variable value while constant value is preferable. Secondly, negative feedback is not possible to generate. Finally, getting rid of the bank which is a trusted entity to maintain reputation balance correctly.

9.5 Decentral Market Self-regulating electronic market, 2016 [?]

Summary: A decentral electronic marketplace to trade digital currencies was created for this project. Users may trade MultiChain balance for Bitcoin. MultiChain can be described as up- and download currency in a peer-to-peer network. When a peer uploads, the balance of that peer increases and the peer can download more effectively. The client for this project is the Tribler Team. Most of the Tribler Teams work revolves around Tribler: an open-source peer-to-peer program which enables its users to find, enjoy, and share content. An earlier bachelor end-project implemented a partial, functional prototype of this idea. We improved the existing concepts and re-implemented a decentralised market from scratch with scalability and as much security as possible, given the limited available development time. This market is the first electronic marketplace to be fully decentralized. There were previous attempts to create such a marketplace, but those implementations fell short in scalability and security. During the research phase, we discovered that the previous decentral market project was not scalable and not production ready, so we made the decision to, together with our client, instead build our application upon a more production-level network platform known as Dispersy. As nothing on the Internet can be trusted which is a problem on its own, we could not make the product as secure as we would have wanted to. At a technical level our contribution consists of 7000+ lines of code, 50+ test suites with a code coverage of +95% and documentation for Dispersy.

Differ from my approach: Decentralized market for currency exchange whereby my approach uses a different network platform and use case.

Obtained result: A decentral electronic marketplace to trade digital currencies.

Remaining open questions: How to create a fitting trust system? How to not have a NAT between the peers?

9.6 The challenge of decentralized marketplaces, 2017 [?]

Summary: Online trust systems are playing an important role in to-days world and face various challenges in building them. Billions of dollars of products and services are traded through electronic commerce, files are shared among large peer-to-peer networks and smart contracts can potentially replace paper contracts with digital contracts. These systems rely on trust mechanisms in peer-to-peer networks like reputation systems or a trustless public ledger. In most cases, reputation systems are build to determine the trustworthiness of users and to provide incentives for users to make a fair contribution to the peer-to-peer network. The main challenges are how to set up a good trust system, how to deal with security issues and how to deal with strategic users trying to cheat on the system. The Sybil attack, the most important attack on reputation systems is discussed. At last match making in two sided markets and the strategy proofness of these markets are discussed.

Differ from my approach: Very similar by giving a rundown of all the research done towards trust enforcements in p2p file sharing, decentralized markets and sybil attacks.

Obtained result: B van Ijzendoorn gives a summary of academical research on decentralization, Sybil attacks, trust and peer-to-peer in relation to marketplaces.

Remaining open questions: Not applied.

9.7 A Peer-To-Peer Platform for Decentralized Logistics, 2017 [?]

Summary: We introduce a novel platform for decentralized logistics, the aim of which is to magnify and accelerate the impact offered by the integration of the most recent advances in Information and Communication Technologies (ICTs) to multi-modal freight operations. The essence of our peer-to-peer (P2P) framework distributes the management of the logistics operations to the multiple actors according to their available computational resources. As a result, this new approach prevents the dominant players from capturing the market, ensures equal opportunities for different size actors, and avoids vendor lock-in. The latest ICTs such as Industrial Data Space (IDS), Blockchain, and Internet-of-Things (IoT) are used as basic building blocks which, together, enable the creation of a trusted and integrated platform to manage logistics operations in a fully decentralized way. While IDS technology allows for secured data exchange between the different parties in the logistics chain, Blockchain technology handles transaction his-

tory and agreements between parties in a decentralized way. IoT enables the gathering of real-time data over the logistics network, which can be securely exchanged between the different parties and used for managing the decision-making related to the control of the freight transportation activities. The practicability and the potential of the proposed platform is demonstrated with two use cases, involving various actors in the logistics chains.

Differ from my approach: It is an academic research which originated from the logistics domain and aimed at solving the contradiction between interoperability and data sovereignty.

Obtained result: High level decentralized logistics system architecture with data flows. Two initial use cases.

Remaining open questions: Development of business models in parallel.

9.8 The Concept Of Decentralized And Secure Electronic Marketplace, 2008 [?]

Summary: For commerce (electronic or traditional) to be effective, there must be a degree of trust between buyers and sellers. In traditional commerce, this kind of trust is based on such things as societal laws and customs, and on the intuition people tend to develop about each other during interpersonal interactions. The trustworthiness of these factors is based, to a large extent, on the geographical proximity between buyers and sellers. But this proximity is lost in e-commerce. In conventional electronic marketplaces the trust among participants is supported by a central server which imposes certain trading rules on all transactions. But such centralized marketplaces have serious drawbacks, among them: lack of scalability, and high cost. In this paper we propose the concept of Decentralized Electronic Marketplace (DEM) which allow buyers and sellers to engage in commercial transactions, subject to an explicitly stated set of trading rules, called the law of this marketplace which they can trust to be observed by their trading partners. This trust is due to a decentralized, and thus scalable, mechanism that enforces the stated law of the DEM. We implement an electronic marketplace for airline tickets in order to illustrate the feasibility of the proposed concepts for decentralized and secure electronic marketplace.

Differ from my approach: Defined roles with clear identification needed to fulfill them. Different use case being fulfilled by the marketplace.

Obtained result: Concept of Decentralized Electronic Marketplace (DEM) implemented with airline tickets.

Remaining open questions: Who is the responsible for deciding if a actor

is fit to fulfill a role on the network?

9.9 Building an E-Marketplace on a Peer-to-Peer Infrastructure, 2004 [?]

Summary: Existing e-marketplaces, built on traditional client-server architectures, severely restrict the scope and dynamics of Business-to-Business (B2B) interactions. Peer-to-peer (P2P) architectures will provide far more decentralised infrastructures, while allowing a much wider range of business patterns to take place. On one hand, the interaction over a P2P network resembles the way real-world enterprises perform business with each other. On the other hand, a small set of simple services is enough to support complex business processes over a P2P infrastructure. Incidentally, most of the required technology is readily available, though it may be necessary to bring in an appropriate integration of different concepts. The paper discusses the implementation of essential services for P2P e-marketplaces, based on one of the leading P2P platforms, and illustrates its benefits by applying the P2P approach to a vendor of industrial equipment.

Differ from my approach: Due to the paper being fairly out dates the project JXTA being used as a peer-to-peer platform for the research is outdated. Currently the best foundation for Bootstrapping an peer-to-peer marketplace is Openbazaar or Dispersy. The research also focuses on shifting b2b to p2p which differs from my research.

Obtained result: Discusses the implementation of essential services for peer-to-peer marketplaces, based on one of the leading peer-to-peer platforms, and illustrates its benefits from a vendors perspective.

Remaining open questions: Advances in e-contracting and trading partner agreements are necessary in order to establish some standardized approaches in the area. This is exactly what i will be researching regarding logistics.