The Land Registry in the blockchain

A development project with Lantmäteriet (The Swedish Mapping, cadastre and land registration authority), Telia Company, ChromaWay and Kairos Future

July 2016

Summary

This report is a part of a project with Lantmäteriet (The Swedish Mapping, Cadastre and Land Registration Authority), Telia, ChromaWay and Kairos Future to study the possibilities of using blockchains as a technical solution for real estate transactions. This report is one part of the project. A second part of the project is a technical demo that illustrates and highlights the opportunities with the technology and supports communication and the continued development of the solution.

Digitalization and the development of new information technology (IT) is one of the strongest forces of change in society. The technology called ”blockchains” is one of the most talked about technologies in recent years, both within the IT community, but also within the financial services industry.

The influential bank, Goldman Sachs, stated the following in December 2015 regarding blockchain technology: ”Silicon Valley and Wall Street are betting that the underlying technology behind [the Bitcoin hype cycle], the Blockchain, can change ... well everything.”[1] In a survey of experts by the World Economic Forum in 2015, the majority (57% of respondents) estimated that 10% of the world’s GDP will be registered in a blockchain by the year 2025[2].

The Economist perhaps got to the heart of the value of blockchains. The magazine called the blockchain ”The trust machine”[3]. Much of the work and activity in society today are transaction costs with the purpose of managing ”trust”. With more trust, transaction costs would be lower and this would represent a large value for society. Today the focus on trust is seen in the vast amount of paper copies and written signatures of a large number of documents. We want important documents to be signed and saved in order to feel secure.

At the same time, there are great advantages in digitizing documents and processes and storing them digitally. However, the creation of trust in digital documents and signatures is not always evident for tax authorities and others. Blockchains can be the future, digital equivalent to signatures and original documents on paper. .

A blockchain is a register of digital fingerprints
In its simplest form, a blockchain can be described as a data file with a collection of digital fingerprints representing digital files[4]. Using modern algorithms we can create unique, digital codes for digital files, for example, contracts, patents, images, etc. Fingerprints are unique to each person.

Humans can prove their authenticity using their fingerprint. The person with the fingerprint, however, cannot recreate the person. It is the same with digital fingerprints. Each document has a unique digital fingerprint[5]. The person with the document can recreate the fingerprint, but the person who has the digital fingerprint does not know what is in the document.

The original file that we created the fingerprint from can be an important document, e.g. a purchasing contract for a property. If a person wants proof of their purchase of a property, they can receive a signature on paper and save it physically. Using digital fingerprints, the digital file can be saved instead, while the fingerprint can simultaneously be saved in a blockchain, e.g. with Lantmäteriet. If I, as the purchaser, am sure that Lantmäteriet is saving the digital fingerprint for my document, I can always prove the authenticity in my file.

As the purchaser of a property, saving the fingerprints in many different locations is an advantage in that it creates redundancy. If any of the databases disappear, the same information can be retrieved from many different places. Since the fingerprints do not reveal what is contained in the purchasing contract, disseminating the fingerprints does not compromise with privacy of the information. We could imagine that everyone involved in a real estate transaction; buyers, sellers, banker, Lantmäteriet, would save a list of the relevant fingerprints. Most parties will also want the fingerprints to be saved in a blockchain, which even more people will save and can verify. Therefore, blockchain technology is sometimes called Distributed ledger, a distributed accounting file with digital fingerprints. We can imagine scanning the original physical copy of a purchasing agreement and making a digital fingerprint of the document. However, if we create digital signatures for an individual, the entire file can be digital, which makes the process easier and still makes the file secure. This also requires that we are able to digitally verify an individual. With modern ID solutions, not least with mobile phones, digital signatures will be increasingly secure over time. They can be connected to the location, individual, human fingerprints, iris reading, patterns in personal movement, etc.

The real estate sector is one area of application where a host of countries and actors have understood the opportunities with blockchain technology. Estonia, Georgia, Ghana and Honduras are examples of countries that have begun to work with this technology or who are now studying the opportunities with the technology[6]. In a country where humans cannot rely on the government or face the risk of a new ruler or dictator, this technology creates the opportunity for people to prove ownership of land, even if government officials do try to revise old agreements and contracts.

Lantmäteriet, Telia, ChromaWay and Kairos Future are happy to help develop solutions for the future within this very promising area of technology.

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About the project

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Introduction

Digitalization and the development of new information technology (IT) is one of the strongest forces of change in society. The technology called ”blockchains” is one of the most talked about technologies in recent years, both within the IT community, but also within the financial services industry.

The influential bank, Goldman Sachs, stated the following in December 2015 regarding blockchain technology: ”Silicon Valley and Wall Street are betting that the underlying technology behind [the Bitcoin hype cycle], the Blockchain, can change ... well everything.”[7] In a survey of experts by the World Economic Forum in 2015, the majority (57% of respondents) estimated that 10% of the world’s GDP will be registered in a blockchain by the year 2025[8].

The technology involves creating digital vouchers or verification records for digital files, e.g. documents or transactions. These verification records can be considered as fingerprints for the digital files. These fingerprints are saved together in groups into a ”block”. The block is then linked in a chain of blocks where the subsequent block also has a verification record, a ”fingerprint” from the previous block. Therefore, it is impossible to add new information to older blocks (links) in the chain without changing the subsequent blocks. The chain’s ability to secure data and history is why it is called ”The Trust Machine” by the Economist[9].

Describing the technology and the applications possible with the blockchain technology is not easy. Partly because it is relatively complex and partly because the area is undergoing intensive development and new applications and new actors are quickly becoming established in the field. The current IT architectures most often obtain security by making the system inaccessible behind firewalls and with special network connections. For example, there are just a few players, such as real estate agents, banks and a number of governmental authorities who can connect their systems to databases at Lantmäteriet. Blockchain technology makes it possible to release verification records for documents, registries, and more outside of firewalls without jeopardizing the security of the original documents.

In practice, confidence in the original transactions and documents improves when several actors have access to the blockchain's verification records. When the verification records are open and demonstrably difficult to manipulate, there is no reason for questioning them, and trust and confidence in them grow significantly, therefore the epithet "the trust machine" is valid.

There is a parallel with the right of access to public records in Sweden. Openness and transparency of public documents and decisions creates trust in government agencies and in the welfare society. Anybody can request documents according to the principle of right of access. The blockchain allows many people — sometimes anyone — to check the verification records. Therefore everyone can trust that the person who has the original document, and who can recreate the verification records, is telling the truth.

The interest in blockchains originated with Bitcoin and cryptocurrencies. For that reason, the financial services industry has been most aware of the development and started working with blockchains. The possibility of establishing alternative currencies is of interest for central banks as well as other actors within financial services. A completely open blockchain, such

as Bitcoin's, is based on global consensus, in other words, the people and businesses that are participating in the system agree to the blocks, which are added to the blockchain. Multiple computers across the globe are needed to communicate and capture information on the blocks and verifications. The open structure has many benefits but it restricts the number of transactions possible to handle. It takes time to create consensus regarding which transactions and blocks will be accepted for many of the actors in an open decentralized IT architecture, even if it's between machines. Funds, shares, bonds, etc. are handled in billions of transactions each minute across the globe. The open blockchains still face significant challenges in handling this flow of transactions, but of course many are also working on solving these issues.

The technology that has already been developed works well for transactions that require a high level of security but are not handled as frequently as securities on the world's stock exchanges. The land registry and real estate transactions is one area where security and transparency are important and where there is a high level of value, but where the required transaction speed and the number of transactions is significantly lower. People who have looked at this area, like The Economist, understand that the value for society may be enormous — not least in countries that lack stable institutions such as legal systems, land registries, etc.

With this project, Lantmäteriet, Telia, ChromaWay and Kairos Future want to show how the blockchain technology can be used for real estate transactions. At the same time, we believe that this technology, and the solutions we develop, will have broader application in real estaterelated issues as well as in a host of other areas, not least in the public sector. The technology, for now, is a combination of a separate blockchain that is also confirmed in an open blockchain. In the future, it is possible that Lantmäteriet and other agencies work together on different blockchain solutions.

The Land Registry today

The value of all properties in Sweden is currently over SEK 11 trillion, or roughly three times the value of Sweden's GDP. For many Swedes, private residences are also their largest asset. The majority of the debt held by individuals is also linked to private residences. Close to SEK 3 trillion of the household debt is in the form of mortgages with real estate as collateral.

Despite the importance of real estate for both society and individuals, there are many parts of the real estate transactions and the information about those transactions that takes a long time to update. Many of these things are also based on out-dated legislation. Information in the land registry can be missing, including registrations by Lantmäteriet, because someone has failed to do what is required during the manual registration.

It usually takes a long time from when the purchasing contract is signed until the bill of sale is signed and the actual transfer of the property takes place. Only long after the first contract is signed the sale is registered at Lantmäteriet, and is until then not visible in the land registry. The sale of tenant-owner rights are also not registered with Lantmäteriet at all, since tenant-owner rights and owners are only registered with the cooperative housing society that owns the properties to be used.

To summarize some of the main issues to be addressed in the current process we can highlight these things:

– One of the problems is that Lantmäteriet is only involved in a few steps at the end of the real estate transactions. As a consequence of this the majority of the process is not transparent, in other words, visible to the public or other stakeholders.

– Another problem is that the system is slow at registering real estate transactions. The time between the signing a legally binding purchasing con-tract and when Lantmäteriet receives the bill of sale and make the approval of the title is often three to six months.

– A third problem is that the issues above have resulted in sellers, buyers, banks and real estate agents being forced to create their own complex, red

tape, processes for agreements between them since they have to make sure that things can't go wrong, and because the value of the transactions is large.

Lantmäteriet is continuously working on reducing the problems and weaknesses in processes and systems. Blockchain technology provides the opportunity to solve many of these issues with a modern IT architecture that Lantmäteriet wants to investigate. In the long run, there is also great value if a solution can be extended, or provide a framework and support for multiple government agencies where appropriate.

Participants in the project

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Disclaimer
This report is a best guess and an effort to explain this very interesting technology and the future of real estate transactions. The report is a simplification of many things and may not be fully accurate in the eyes of the participants or the organizations they represent. No one takes responsibility for the content or the interpretations of the report. We look forward to learning more about the technology and its implications for society. Magnus Kempe is the author of the report.

The technology behind blockchains

In this part of the report, we will try to describe the basics of the technology. In the next part, we will describe real estate transactions today and in the future.

A distributed list of fingerprints

A central part of what is currently called blockchain technology is the ability to create unique verification records, or vouchers, for digital files, for example, photos, transaction lists, registers, agreements, video films, patents, etc. Essentially, this includes everything that can be stored as a digital file.

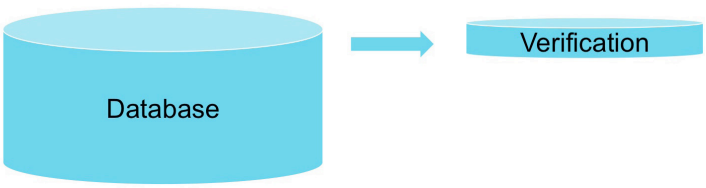
Using an advanced ”fingerprint algorithm” any digital file can receive a unique code. This is technically called a cryptographic hash. An example of an algorithm that creates cryptographic hashes is SHA256. This algorithm takes all of the ones and zeros that describe a digital document and recalculates them, according to a defined, but unpredictable result.

An illustration of how an algorithm like SHA256 works is: Take every third digit in the file, multiply the number by 7, and divide the total by every fourth number in the file. Combine every number not used in the previous calculation to the number you have, etc. In the end, a series of digits and/or letters is created, in other words, a hash. If the same digital documents and the same hashing algorithms are used, the result will be the same hash. However, it is not possible to understand what the file looked like that created the hash — it includes just a few characters, for example, 32 numbers and letters. In the same way that a fingerprint is unique, the hash is unique for a digital file. But if you look at a fingerprint, you do not know what the person looks like, and in the same way a person looking at the hash does not know what the digital file looks like.

A purchasing contract for a real estate transaction that is scanned and becomes digital is an example. The hash that is created from the document is unique. For example, if a bank receives a purchasing contract sent via email, the bank can see that the document is correct. The bank takes the document and run the algorithm SHA256 on the file. The bank can then compare the hash with the hash that is on the list of verification records, assuming that it is available to the bank. The bank can then trust that the document really is the original purchasing contract. If someone sends an incorrect contract, the hash will not match. Despite the fact that email has a low level of security, the bank can feel confident about the authenticity of the document.

It is the verification records — in other words, the hashes, which are saved in the blockchain.

We can imagine that an individual government agency or organization may see an advantage in creating their own database of verification records, hashes. Different parts of the organization, then can check the authenticity of documents and files by cross-referencing the list of verification records.



The owners of the agreements, documents, images, patents, etc. also benefit from having the list of verification records distributed to more stakeholders. A high level of redundancy, in other words, multiple copies, reduces the danger of a single list of verification records disappearing. When multiple people have access to the verification file, the trust in that file grows. Everyone can therefore be confident that their document is considered authentic because multiple people have access to the list of verification records.

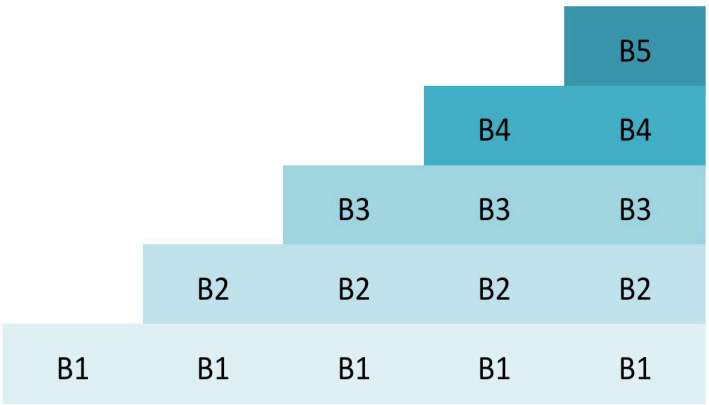
The blockchain is a way of saving the list of verification records

Of course, there are large numbers of documents and large amounts of data that can benefit from having an external verification service. Therefore, one of the challenges is to be able to manage the large number of verification records/hashes, the blockchain is a way to save the hashes as a group in a list. A large number of hashes are saved as a group, i.e. a block.

Each block with verification records is then distributed to the persons who have access to the blockchain, sometimes even publicly to anyone and everyone. The person who is in charge of approving which of the transactions should be saved and distributed in a blockchain can do this more easily by grouping the hashes in a block. The alternative is to approve each hash one by one. In other words, it is not necessary to make blocks with many transac-tions, but the technology has the benefit of disseminating many verification records at the same time. In addition, something called a Merkle tree can be used to convert multiple hashes into one and therefore to save space in the block.

Blockchains are divided into different groups. The two main groups are open blockchains and private blockchains. In a private blockchain, there is one or a limited number of actors who approve the hashes that are to be saved in the blockchain, using digital signatures. For example, it could be a group of governmental agencies. In an open blockchain, practically anybody can approve the block according to predetermined rules. The largest open blockchain is the one that builds up the digital currency or cryptocurrency, Bitcoin. If the system and participants in an open blockchain accept the block, they start building on the next one.

The blockchain is called a blockchain because each block is linked back to the previous block. Each subsequent block gets a hash, i.e. a verification, of the previous block, which makes it difficult to cheat by creating another version of what happened. For example, it is not possible to enter a new verification into an old block without changing the subsequent blocks. If a lot of people have saved the blockchain, they can see that changes have been made and that the manipulated blockchain is not correct.



Who registers the block?

The blockchain and its verification records can be accessible to a large group of actors. The persons who approve which verification records will be added to the block, however, in practice are most often limited. In an open system, such as Bitcoin, the system is limited in that enormous numbers of fast processors and energy are required to win the right to approve the verifications in a block. In a restricted systems with a private blockchain, for example, the system that NASDAQ launched as a trial for trading of unlisted stocks, NASDAQ themselves are the ones who approve the transaction lists and who gets to add transactions. In the case of NASDAQ, this is natural because this is the way they are working in their existing systems. On their exchanges, only persons with access to the trading system and who are connected to their exchanges can trade. Correspondingly, there are only a few actors, such as real estate agents and banks who have direct links to the the databases of Lantmäteriet.

Blockchains can be a mix of private and open ones, and in these cases several actors can approve transactions but not just anybody. In the future, we can imagine that private organizations and groups of IT companies, banks, central banks and other agencies will have blockchains that they monitor and regulate. While approval of the block is limited, access to the verification lists can be open, e.g. to all Swedish citizens for example, or on the Internet.

The power to approve the blocks

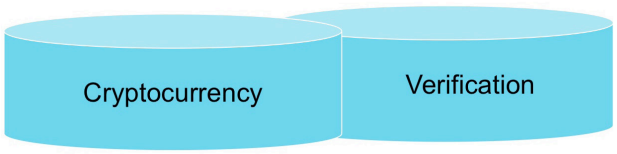
The advantage of having multiple actors who can approve the block is that the system is more transparent, for example. The difficulty is to ensure that those people who contribute to the system by checking and approving transactions are doing it in the best interest of everyone, and they need some incentive to do this. In a government agency or at a bank or

at a consortium, this isn't a major problem. The value of the service must naturally justify the investment due to greater security, increased transparency, efficiency, and revenues from the people who use the service, etc. In Bitcoin's blockchain, the incentive is determined by who provides the greatest security for the system. Those who contribute with the most energy and processing power also increase the system security the most. These are called min-ers - these are the persons and organizations that uncover codes that are needed to approve new blocks in the blockchain. By giving the power to approve the block to those who are contributing most to the security and speed of the system, the system ensures itself of a high level of security and processing power. Anyone who wants to take over the system needs to exceed the power of the other people who are maintaining the system. At the moment their processing power in terms of hashing is far greater than the 1000 largest supercomputers in the world combined, and the processing power is increasing steadily as well. In practice, those people who are maintaining the system are not particularly interested in the power over the list of verification records since it doesn't do anything other than save the verifications and transactions but not the original documents. There are thousands of copies of the verification list so it cannot be changed without everybody noticing it. What those people who approve the block receive instead is a small payment from the verification records that are entered into the system.

Introduction of a digital currency

When Bitcoin was launched and the first block was created, it was practically free to add verification records. Still today it costs very little to register a verification record in Bitcoin's blockchain. Payment for the registration of the verification records is also important at the same time. If it had been free, the system would have had a harder time handling overloading of verifications. The problem with spam in the form of email depends in part on the fact that it is free to send.

The first invention in the area that got international attention was not the blockchain but the cryptocurrency Bitcoin. By creating a currency the system also became autonomous in the sense that payments for transactions are made by the currency in the system. The miners who dig up and approve blocks with verification records are paid by the system in the form of Bitcoin, which are digital codes that stay in the system. This system is programmed in such a way that Bitcoin is only created when a new block is created, and these are awarded to the person who identified the block and approved the verification records. Even private blockchains work in several cases with digital currencies as a part of the system. The hashes are actually entered as comment fields beside a digital currency or cryptocurrency.



The lottery determines who provides the approval

In the case of Bitcoin, an open lottery determines which computer or ”miner” wins Bitcoin as well as the registration fee for the verification records and therefore approves the next block. The system generates a number that all computers that want to can try to guess[10]. The person who has many computers and uses a lot of processing power and energy can guess many times and therefore has the greatest chance of guessing the series of digits correctly first. It is a little bit like a lottery. The person who purchases a lot of lottery tickets has a greater chance of winning. In

the case of Bitcoin, the person who purchases many processors and use a lot of energy has the greatest chance of winning. In order to take over the system, you need to have as much processing power as possible so that you are sure to win the lottery many times in a row. Only then can the system be manipulated and controlled in a way that other people who are part of the system do not accept.

Cryptocurrencies remain in the system

An important point with cryptocurrencies in the blockchain is that these remain in the system. Cryptocurrencies can be transferred to another person as a code that can provide access to the cryptocurrency in the system. However, the cryptocurrency cannot leave the system. In other words, the person who owns a cryptocurrency owns an encryption code to an amount of an encrypted currency in a blockchain. If the cryptocurrency is transferred, someone else has access to the code that controls the currency. The word ”chain” is therefore particularly relevant for of cryptocurrencies. They are transferred like a chain from one owner to another, but the chain remains linked together.

Do cryptocurrencies have a value?

The idea of creating digital money is naturally something that has attracted many more or less serious actors. The use of money for society is usually described with 3 functions:

1. As a medium for payments
Money makes it easier to trade. It is expensive and cumbersome to trade with cows and coffee beans. Money makes it cheaper and more efficient to trade.

2 A standard for accounting
Money makes it easier to compare and control businesses and people. We can see how much a company is worth, how much a person earns when there is a standard for reporting amounts that everyone understands. Tax agencies, investors and others benefit greatly from this.

3 A way to store value

Money makes it possible for people to save what they earn, and spend or give it away at a later date. The value can be transferred to another point in time. We can also spend earlier and get indebted i.e. get the value first and earn the money later.

If we look at Bitcoin, as an example, so far its primary demonstrated use has been as a medium for payments. Even if the currency's value relative to the US dollar, for example, fluctuated a lot in the initial years, this is a minor problem for the person who wants to transfer money cheaply. One of the challenges that Bitcoin currently faces is that the system in its current form cannot handle large numbers of transactions. The global number of transactions of money and various financial assets is billions per second. This is not possible to handle for Bitcoin today. The system is secure, but it can not handle frequent trades.

The extent to which Bitcoin is an option for storing value is difficult to answer. In general, we can say that all money is currently based on trust. As money has transitioned from raw materials to today's zeros and ones in the banking system, the amount of money in circulation has increased to dizzying amounts and at dizzying speeds. We are not able to answer in this report whether cryptocurrencies have a future are not, but a short text about money throughout history is provided as an appendix.
The subject cryptocurrencies is related and interesting but the process for

real estate transactions and smart contracts that is described in this report and shown in the technical demo does not need to use any cryptocurrency.

Coloured coins

Regardless of whether cryptocurrencies are valuable in reducing transaction costs for international payments or whether they have value that can be saved and stored, they still have a value that has nothing to do with the function of money. Cryptocurrencies can store other information that is stored in the blockchain.

Digital currencies can, in certain cases like Bitcoin, be the carriers of information and agreements that are controlled by anyone that wants to ascribe value and information to them. The term ”Coloured Coin” highlights the opportunity of giving a ”color code” color to a cryptocurrency. The color follows transactions for a particular piece of cryptocurrency and provides the opportunity to give special meaning to a transaction chain of a set of cryptocurrencies.

LHV bank in Estonia has worked with ChromaWay to create a service that is called Cuber based on this logic. The bank enters the color identities into the code of the cryptocurrency Bitcoin. LHV guarantees the asset value of the particular pieces of Bitcoin whomever owns them. In their case the pieces of cryptocurrency represent Euro. When someone performs a transaction in Euro in Cuber, the properties of the color-coded cryptocurrencies are transferred so that they represent a Euro value with a new owner. The value of the Bitcoin currency in this context is completely uninteresting. The cryptocurrency is used as a way to store information, and LHV determines what this information represents in terms of value. This is not very different from the activity of a bank. The bank is currently responsible for what the digital codes in their databases represent in terms of value, which they also reconcile with central banks, markets, and so forth. The advantage for LHV Bank with Cuber, among others, is that the transaction costs are lower and that trade with the currency, i.e. the Euro, can occur around the entire world.

Smart contracts

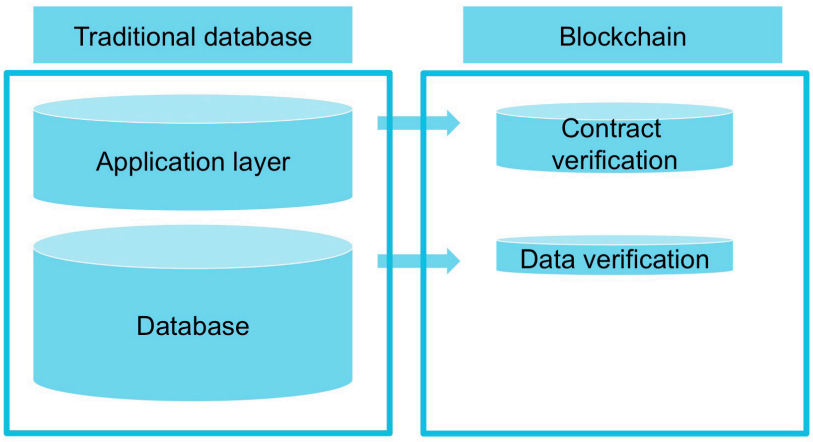
As described above, colored coins are designed to allow a digital code in a blockchain to represent something else that can be transferred, primarily any asset class. An even more interesting coding possibility is that we can add additional information that is stored in the blockchain that regulates, for example, data authorization and storage. In addition to separating the verification record from the traditional database structure, we can also separate parts of the application layer. Similar to hashes/verification records, only the person who owns or has programmed the coding and the rules for authorization and storage can interpret how the application works.

The system of adding logic and properties that are normally part of the application layer in an IT architecture has been called “smart contracts”. However, there are many different interpretations of what is meant by the term ”smart” in this context. Therefore, we also use the term ”embedded contracts” to highlight the feature that we are after. The logic is registered in, embedded, in the blockchain.

The cryptocurrency/system Ethereum was built with a focus on creating smart contracts/embedded contracts in the blockchain. Apart from Bitcoin, Ethereum is one of the current blockchains that is talked about most. Ethereum permits arbitrary code to be executed in Ethereum’s blockchain as long as you pay for the number of cycles that is required to run the program.
The technical demo that is currently being built as part of this project, uses ChromaWay’s open source technology and programming structure Ratatosk, which creates smart contracts/embedded contracts in a blockchain. Open source is an important part of ensuring confidence in the

code. Everyone can inspect the code and detect potential weaknesses. In practice, a parallel blockchain is created which can execute the transactions between the parties more quickly. When the contract is finished, it is added to Bitcoin's blockchain as an extra back up. Everyone involved can also save all or part of the blockchain, which covers the personal transactions in the system. Both buyers, sellers, banks and real estate agents can therefore verify the history of a transaction.

An additional benefit of this procedure is that the solution is even easier to transfer to an alternative blockchain or to several blockchains in parallel. Let's assume that a few government agencies jointly build a blockchain that they control. The solution we are building with the technical demo can be easily secured, even in this blockchain. A solution with Coloured Coins is somewhat more hazardous and difficult to transfer since the code is written on top of a specific cryptocurrency.



Safeguarding identities

A central part of the practical application of blockchains is the identification of what the digital codes will represent in the physical world. As described above, it is LHV Bank, Lantmäteriet or someone else behind a solution that is the organization that determines what the digital codes represent and who is authorized to transfer or act in a contracts. In other words, Lantmäteriet guarantees which digital representation a specific property has. Another central part is the identification of the actors who will have rights to act in the system. For this, a secure ID solution is required. This solution also needs to be easily accessible to the actors involved.

If we look to the future, we see a world where mobile phones play an increasingly important part in the ID solutions being developed. Telia is a company headquartered in Sweden that is well positioned to create such a solution for the future. Telia already have an ID solution that can be used in mobile phones and can register people with or without a personal identification number (The Swedish equivalent of a social security number). In addition, Telia's solution is currently used by agencies within the healthcare system in many county councils. Telia is also present in several markets and therefore has the resources to do this and comply with existing and forthcoming EU requirements.

Real estate transactions today

The goal of the project is to improve how real estate transactions are performed. The most common real estate transaction is the purchase of a private residence. Here we first describe the main features in this process as it stands today. Following this we will explain how we believe it will look in the future. Using the technical demo, the project group also illustrate the future process.

Real estate transactions by provate persons via real estate agent today

1. A property owner wants to sell her property.
2. The property owner, i.e. the Seller, contacts, a real estate agent and draws up an agreement for managing the sale of the property.
3. The agent contacts Lantmäteriet and orders an excerpt from the real estate registry database in order to check the information about the property, i.e. that the seller is in fact the owner and can sell the property.
4. The agent puts the property up for sale and markets the property to potential buyers.
5. The Buyer goes to a bank, the Buyer's bank, and asks for a loan commitment. The bank checks the Buyer's credit rating, often in a digital registry such as UC. The Buyer's bank approves the loan commitment.
6. The property is put out on display to the market and eventually offers are made.
7. The Buyer that makes the highest offer makes an initial inquiry about credit options for the specific residence with the Buyer's bank.
8. The Buyer's bank inspects the property and evaluates the credit options for the Buyer. The property and the Buyer may be inspected again in the respective databases.
9. The Bank approves the purchase price and the amount of the loan for Buyer, which is often communicated over the phone.

10. Prior to signing the purchasing contract, the agent again checks on the seller and the property with Lantmäteriet. The agent also often checks that the Buyer actually has a loan commitment from the bank.
11. A purchasing contract is drawn up between the Buyer and the Seller together with the agent, often at the agent's office. Often four copies of the contract are created, one for the seller, one for the Buyer, one for the agent and one for the Buyer's bank.
12. The contract is sent by the Buyer to the Buyer's bank, often by regular mail.
13. The bank sends credit documents to the Buyer, often via regular mail.
14. The Buyer signs the loan documents and also writes a note to the bank to pay a down payment into the agent's escrow account.
15. The Buyer sends the signed loan agreement to the Buyer's bank via regular mail.
16. The Buyer's bank receives the loan documents and pays the down payment to the Agent.
17. The property may be inspected by the Buyer.
18. The agreement becomes binding if there were conditions in the form of inspection.
19. The agent pays the down payment to the Seller, while deducting the agent's fees.
20. After this step, the main thing remaining is to actually sign the bill of sale, transfer the possession of the property and make the final payment. This is often done roughly 3 months after signing the purchasing contracts.
21. Closing: The agent checks on the property and the Seller in the database of Lantmäteriet again to ensure that there aren't any problems that would prevent the sale of the property.
22. The Buyer and Seller sign the bill of sale at the agent's office. The Buyer signs for the mortgage and any other mortgage deeds on the property.
23. The purchase price is paid by the Buyer's bank to the Seller's bank. Often this payment is made via a direct deposit where the Seller's bank and the Buyer's bank confirm that the transfer has been made.

24. The Buyer, Seller, as well as the agent, each save a copy of the contract, as well as a copy for the Buyer's bank, and the Buyer may now move into the property.
25. The Buyer's bank goes into the mortgage deed system of Lantmäteriet and requests the mortgage deed on the property from the registry.
26. The Seller's bank releases the mortgage deed to the Buyer's bank
27. The agent sends the bill of sale to the Buyer's bank.
The Buyer's bank sends the title registry application along with the bill of sale and any application for a new mortgage (i.e. an increase in the mortgage beyond the existing mortgage deeds) to Lantmäteriet.
28. Registering the property title: The Buyer is granted a Property title by Lantmäteriet, and the title is registered in the land registry.
29. A new mortgage is granted, and the Buyer's bank is registered as the mortgage deed holder in the mortgage deed system.
30. Lantmäteriet decides on any service charges and stamp duty (based on the purchase price or the assessed value of the property).
31. Lantmäteriet is paid (usually from the bank) via an automatic payment account for the title and the mortgage deed.
32. Lantmäteriet notifies the Buyer's bank, i.e. the title applicant, by regular mail that the title has been granted.
33. The Buyer's bank notifies the Buyer that the title has been granted and the transaction is performed via regular mail.

Summary of the current situation

What we see above is that the Lantmäteriet is involved relatively late in the process. Not until item 28 does Lantmäteriet make any active decisions or receive any of the submitted documents. Prior to that, it is primarily the agent who checks the land registry to check the ownership of the property. There are several disad-vantages with this system. Lantmäteriet is the actor with the highest credibility, and if Lantmäteriet is involved earlier, the confidence and transparency in the process increases.

The second thing that can be noticed is that the process takes a long time. There are likely advantages with the process because the buyer and seller of a residence will often want to have time to sell the previous residence and find a new one. It also takes significant time to prepare all the information. The agent needs to check on the owner and the property several times. The bank may check credit information several times. Information that is already listed in the purchasing contract is written again into the bill of sale.

A third thing we notice is that there are still a lot of documents that are signed on paper and sent via regular mail. Checking these documents and the identity of the people who signed them must be done manually. Today, agents, buyers and sellers can be sitting for two hours signing several hundred pages of documents when signing a purchasing contract, since all of the documents and often all of the pages in several documents need a signature or initials written by hand. This takes time and it's easy to make mistakes.

The amount of documentation and information that must be saved also leads to mistakes. In 2015, Lantmäteriet granted 91% of all applications and 94% of all e-applications. Therefore, it is relatively common that papers need to be filled in a second time because they are incomplete or there are mistakes.

All of these records must be stored by law for ten years, which requires physical space and increased security, e.g. in the agent's offices and at the banks. Searching for information in old records is also time-consuming.

Property transactions in the block-chain

The previous example illustrates the current process for real estate transactions. With the example below, we want to illustrate what this would look like in the future. The technical demo that is also being developed as part of this project makes it possible to illustrate and test the process, including a large part of the suggested improvements below, in an app or on the web.

Purchasing small houses by private persons via real estate agents in the future

1. A property owner wants to sell a property. ***New solution:*** The property owner can check their ownership and whether there are any obstacles to the sale by themselves using the app from Lantmäteriet (”My property account”) and by verifying their identity via their mobile phone.
2. The property owner, the Seller, contacts, a real estate agent and draws up an agreement for a real estate sale. ***New solution***: The property owner, the Seller, contacts a real estate agent and commissions the agent to sell the property via the app. The agent accepts the offer to manage the sale of the property. In practice, the agent can also guide an individual through these steps in the app.
3. The agent contacts Lantmäteriet and orders an excerpt from the property database in order to check the information about the property, i.e. that the seller is in fact the owner and can sell the property. ***New solution:*** In the future, this step is superfluous because the agent can see the information directly in the app and any applications for changes in the land registry are communicated immediately.
4. The agent puts the property up for sale and markets the property to potential buyers.

5. The Buyer contacts a bank (digitally), the Buyer's bank, and asks for a loan commitment. The bank checks the Buyer's credit rating, often in a digital registry such as UC. The Buyer's bank approves the loan commitment.
6. The property is put out on display to the market and eventually offers are made.
7. The Buyer who makes the highest offer makes an initial inquiry about credit options for the specific residence with the Buyer's bank.
8. The Buyer's bank inspects the property and evaluates the credit options for the Buyer. The property and the Buyer may be inspected again in the re-spective databases. ***New solution***: The Buyer's bank is given access to the property via the app and the bank can check the property there. Information about the condition of the property, inspection report etc. can be included in the app or linked to the app.
9. The Bank approves the purchase price and the amount of the loan for the Buyer, which is often communicated over the phone. ***New solution***: The Buyer's bank can provide preliminary approval of the loan so that the agent and the Seller can be confident that the Buyer has the ability to pay.
10. Prior to signing the purchasing contract, the agent again checks the Seller and the property with Lantmäteriet. The agent also often checks that the Buyer actually has a loan commitment with the bank. ***New solution***: In the future, the property does not need to be questioned again because the latest information is always available and can otherwise be checked directly in the app.
11. Often four copies of the contract are created, one for the Seller, one for the Buyer, one for the agent and one for the Buyer's bank. ***New solution***: The necessary information is registered in the app, e.g. date of possession and purchase price in digital fields, which reduce the risk of the contract being incorrectly formulated. Signatures are provided in the app using Telia ID or another ID solution. Everyone involved can re-tain a copy of the agreement and the verification record in the blockchain in their mobile phone or computer for extra security. The contract cannot be lost or

falsified. If anyone wants to print out a paper copy, it is easy, but it is then just a copy that is only valid for the time when it is taken out. The contract is also shared with Lantmäteriet, who registers the pending property title at no cost until the final verification record for the transfer (bill of sale) is distributed. The information about the purchase price and the property can be made public, which provides security for the Buyer and Seller and is important information for e.g., Sweden's national statistics, for the central bank and others etc. in order to assess inflation, household assets, etc.
12. The contract is sent by the Buyer to the Buyer's bank, often by regular mail. ***New solution***: The Buyer's bank can see the signed contract in the app and does not need to send it.
13. The bank sends credit documents to the Buyer, often via regular mail. ***New solution***: The credit documents can be attached to the app and signed directly when the purchasing contract is written up. ChromaWay's technical solution makes it possible to make the credit documents accessible only to the Buyer and the Buyer's bank. If the Buyer does not want to display how much is being borrowed to other parties, access to the credit documents can be hidden.
14. The Buyer signs the loan documents and also writes a payment order to the bank to pay a down payment into the agent's escrow account. ***New solution***: The Buyer can sign the loan documents as well as the payment order for the down payment directly with signatures in the app.
15. The Buyer sends the loan agreement to the Buyer's bank via regular mail. ***New solution***: The loan documents do not need to be sent via regular mail because the bank gets a digitally signed copy of them directly when the purchasing contract is written.
16. The Buyer's bank receives the loan documents and pays the down payment to the Agent. ***New solution***: The bank can pay the down payment to the agent directly because the payment order is signed digitally by the Buyer.

17. The property may be inspected by the Buyer.
18. The agreement becomes binding if there were conditions in the form of inspection.
19. The agent pays the down payment to the Seller, while deducting the agent's fees.
20. After this step, the main thing remaining is to actually sign the bill of sale, transfer the possession of the property and make the final payment. This is often done roughly 3 months after signing the purchasing contracts.
21. Closing: The agent rechecks the property and the Seller in the database of Lantmäteriet to ensure that there aren't any problems that would prevent the sale the property. ***New solution***: With the new solution, this is not needed. The pending property title is already granted. If no changes have been made, this is displayed and the next stage can be processed without additional steps.
22. The Buyer and Seller sign the bill of sale at the agent's office. The Buyer signs for the mortgage deed on the property. New solution: In the new solution, this is done with digital signatures and digital identification. The risk of incorrect formulations in the bill of sale is minimized since the necessary information is already there and any new information is entered digitally and verified automatically.
23. The purchase price is paid by the Buyer's bank to the Seller's bank. Often this payment is made via a direct deposit where the Seller's bank and the Buyer's bank confirm that the transfer has been made.
24. The Buyer, Seller, as well as the agent each save a copy of the contract and write one for the Buyer's bank, and the Buyer may now take possession of the property. ***New solution***: With the future solution, the contract is already available in the app. If anyone wants a physical copy of the contract they can print it out. The copy also has a verification code that is

registered in the blockchain.
25. The Buyer's bank goes into the database of Lantmäteriet and takes over mortgage deed in the mortgage deed registry of Lantmäteriet.
26. The agent sends the Bill of sale to the Buyer's bank. ***New solution***: The bill of sale and documentation for the mortgage on the property is already accessible to the bank via the app.
27. The Buyer's bank sends the application for the property title along and a new mortgage (i.e. increase in the mortgage beyond the existing mortgage deeds) to Lantmäteriet. ***New solution***: This information is already accessible and distributed to Lantmäteriet in items 11 and 22.
28. Registering the property title: The Buyer is granted a Property title by Lantmäteriet, and it is registered in the land registry. ***New solution***: The pending property title is already granted and the process of verifying the agreement can proceed more quickly through automated decisions because the risk of incorrect formulations in the bill of sale is reduced when this is done using digital fields.
29. The Buyer's bank is granted a new mortgage deed, which is registered in the mortgage deed system.
30. Lantmäteriet decides on any service charges and stamp duty.
31. Lantmäteriet is paid via an automatic payment account for the title and the mortgage.
32. Lantmäteriet notifies the Buyer's bank, i.e. the title applicant, by regular mail that the title has been granted. ***New solution***: Lantmäteriet's record of the property title and the mortgage is shared via the app and all parties can see that the title has been granted.
33. The Buyer's bank notifies the Buyer that the title has been granted and the transaction is performed via regular mail. ***New solution***: This step is not needed. Information about the property title goes directly to the Buyer, Seller, agent, Buyer's bank and the Seller's bank via the app.

Summary of possibilities with the new technology

The example of the future process includes a number of improvements. The time between which the purchasing contract is written and when important information as well as security in the form of the pending property title is registered with Lantmäteriet can be reduced from 4 months to a few days. Eventually, this could take place more or less in real time. The Buyer is granted the pending property title, and the property cannot be sold a second time by the seller.

The information that is needed for the bill of sale is already registered in the system for the most part. Therefore, in practice, the buyer and seller sign the same information upon taking occupancy. The risk that the property title will not be granted is sharply reduced since the system can ensure that the information that is required by law is included in the system and is required by the system in order for the parties to be able to provide their signature. Lantmäteriet wants it to be easy for citizens and stakeholders to do things correctly, and this is considerably easier in a digital system.

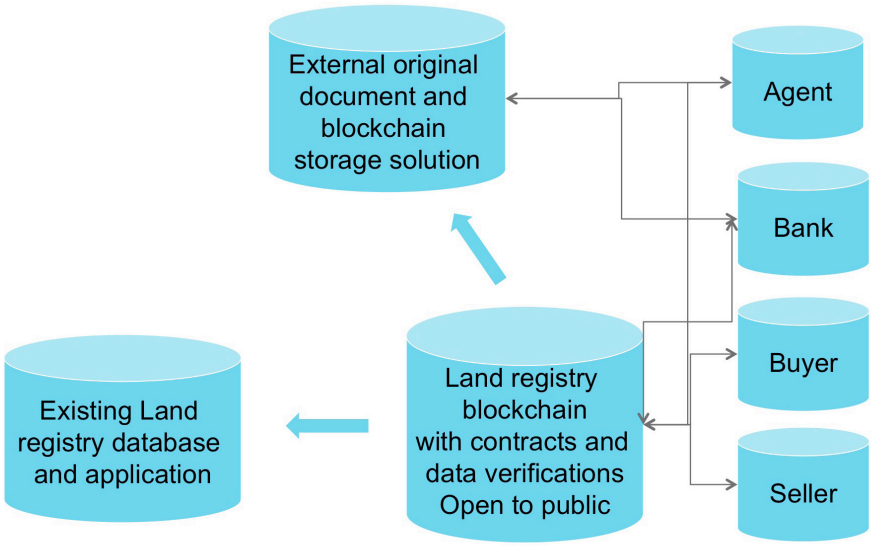
Digital signatures provide a significantly greater level of security that the correct people will be filling out the documents rather than using an all paper process. Since digital signatures are provided with the same application at several instances, the risk of errors and fraud is reduced. The process involves multiple contact points and multiple signatures by the parties involved. This increases confidence in the system since it is more difficult to manipulate the system over a long period of time.

In addition, the purely manual portion of sending paper by mail is streamlined and made more secure. All of the parties can save the digital files and verification records of the entire chain of events digitally. Paper copies can be printed out if desired, but the process saves a lot of documentation.

Simplified overview of the technical solution

In an initial stage, the database of Lantmäteriet remains intact. Updates to the land registry are retrieved from the blockchain and are then also checked by Lantmäteriet. Registration in the blockchain is digital and based on the legal requirements, which minimizes errors in the information.

The blockchain for the transactions is open source and is checked by Lantmäteriet, but can be verified by anybody. The chain of authorization, signing with a Telia ID, etc. can be edited. The blockchain saves the verification records of documents such as the bill of sale and the purchasing contract. Storing the original documents and their verification records can be performed by an external party, but can also be stored digitally by each party in the agreement, the bank, buyer, seller, agent, etc. The documents and verification records are then stored in multiple locations, which creates redundancy. The verification records are also recorded in an external blockchain, which means that all of the parties can feel secure that they can re-create and demonstrate the chain of events on their own, in the event that the other parties suffer a breach of data or similar event.



Development steps for the future

The development of an IT solution using blockchain technology for real estate transactions is a long term project that is best implemented in stages. The first stage is for the project group to create a plan for a concrete test bed project. The plan should include a list of requirements in terms of the IT environment with servers, storage, nodes that verify the blockchain, local storage in the mobile phone, in the cloud, etc. These can then be drawn out, designed and tested to ensure the proper IT architecture, and to check the processes and security of the solution. The project will also need to involve users, primarily banks and real estate agents, on an ongoing basis in order to ensure that the service is useful. When the test bed for the solution has been shown to work, an assessment can then be made to determine which services should be launched in which order. A theoretical hypothesis for rolling out the service is described below.

The first stage of the IT solution

In the first stage, the key is not to become dependent on any specific blockchain or to jeopardize the security of the existing system. Therefore, the main focus in the initial stage is to augment the existing process with increasing transparency, security and access using the process described above. The suggested process focuses on drawing up contracts between buyers, sellers, banks and real estate agents. The land registry of Lantmäteriet is, in principle, entirely separate from the solution.

In the current process, Lantmäteriet has very little involvement. Buyers and sellers, real estate agents and banks will have done a lot of the work on a given real estate transaction before Lantmäteriet receives information about what is in process. Likewise, the people who are involved in a real estate transaction cannot receive any information about it from Lantmäteriet because nothing is recorded. The real estate agent and the Buyer's bank almost always run checks on the property for sale in the database of Lantmäteriet, but there is no information about the changes to the property, e.g. the change in ownership. Today, it is possible to notify Lantmäteriet about the start of a property transfer and, for example, to request the property title once the purchasing contract has been written. In these cases, the property title remains pending, but this is unusual in practice because it involves duplicate work and duplicate fees. With a digital solution this is a more natural step, and no additional work for Lantmäteriet, which means that duplicate fees do not need to be charged.

By having Lantmäteriet create a system where the course of events is recorded, confidence can be increased significantly for the parties involved in terms of the agreements and the communication between them; in other words, the process that is currently outside of the control and oversight of Lantmäteriet. This has a many positive side effects. The possibility of earlier registration of pricing information for the properties during a sale is one example. Assessments of price trends, house-hold assets, the interest rate by the Riksbanken (Swedish Central Bank), etc. currently depend on data that is roughly six months old in terms of small houses.

The second stage of the IT solution

While the IT infrastructure for the land registry in the section described and the current property registration process is modern, there is a need for even more modern IT architecture for mortgage deeds and mortgages. Transitioning to a combined cloud solution with verification records in a blockchain is probably appropriate for Lantmäteriet's IT architecture. Because there are significantly fewer actors involved in processing mortgage deeds, this solution can also be limited to the existing actors, primarily banks and other lending institutions, and the technology can demonstrate its functionality before potentially made available to respective property owners.

IT solution in te long term

In the same way that Cuber has created a solution where digital codes can represent Euro, digital codes can also represent properties. In the long run, it is possible that this will become a natural IT structure. The land registry is held directly in the blockchain, but it is Lantmäteriet that guarantees the interpretation of the codes in the blockchain, such as the respective property, and owner. The database of documents resides in one or a few cloud services, but the verification records of the documents are also secured by the verification records in a blockchain, which several government agencies and perhaps even other actors are responsible for. It is possible that the blockchain can be saved by anybody, even if it cannot be man-aged. This solution will clearly take a few years before it is tested and verified, but development by the major IT actors, universities, government agencies, banks, etc. is currently intense.

Blockchains in the future

Several government agencies across the globe are now working on blockchains in general, and there are a few well-known cases of applying them to real estate transactions. Georgia has started researching the opportunities with blockchains for their land registry. Estonia has an infrastructure where public registries can be reviewed, including of properties, using blockchain technology. Ghana is also looking at a solution[11]. The first country that was rumored to be involved was Honduras, even though their potential projects have not been confirmed.

The Chief Scientific Officer for the UK Government has written an extensive re-port where they encourage the British government and British companies to invest more in blockchain technology and see a very important role for blockchains in the future[12].

This initiative should be seen in this context. There is major international interest in blockchain technology and its importance for the future, not least for property registries and real estate transactions. For Sweden, which is a leading IT nation with a strong tradition of an open and transparent society, blockchains as a technical solution can be a supplemental solution that can reinforce Sweden's international role when it comes to new technology and the government's relationship with its citizens. Questions about integrity and confidentiality are increasingly important in society as the amount of data that is being collected grows. Storing the data takes place in a growing number of locations, and analysis of this data is becoming increasingly advanced. Using blockchain technology, the openness and confidentiality can be managed. Through encryption, hashing and independent verification, citizens can be provided access to and control over their own information to a greater degree than previously, e.g. patient information and other important documents. Access to information can be controlled by the citizens if appropriate.

There are many opportunities here and there will certainly be problems along the way that must be solved.

The group of persons, agencies and companies that are interested in the technology and believe in its power include many of the most knowledgeable, powerful and well-informed persons and institutions in the world. The heads of the world's largest banks such as UBS, Barclays, Bank of America, etc., the central banks of England, Canada, Singapore, countries such as Japan and China, IT companies such as Microsoft and IBM, analysts such as Gartner and educational institutions such as MIT have expressed interest. Many people talk about blockchain technology being an important part of the future.

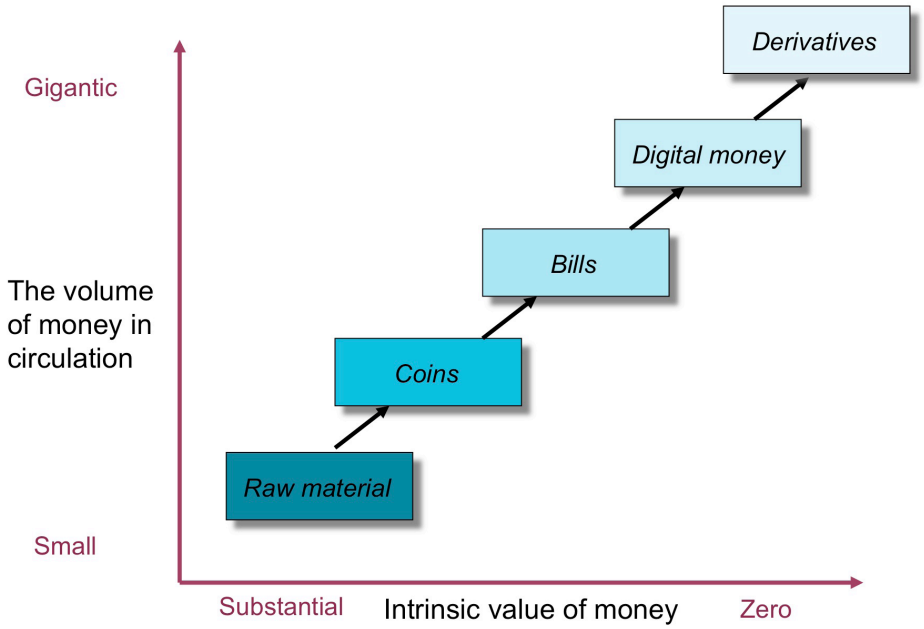
In our project group, we see an exciting time of learning and new solutions ahead of us with a major benefit for society. And we feel its better to be part of the future then merely sit and watch when the future passes by.

Appendix 1. Money

The growing interest in blockchain technology has its origins in Bitcoin and the blockchain that Bitcoin is based on. Explaining Bitcoin and its blockchain can be rather difficult because both the concept of a block-chain as well as money are difficult to understand. This is one description of a perspective on money based.

More money creates a greater need for trust

What has been used as money has varied through history. In brief, we have seen money develop from raw materials, coins and bills up to today's zeros and ones. This transition has meant that the value of the actual currency has been reduced.. The volume of money in circulation has also increased sharply.



Raw material currencies
Different types of raw materials have been important forms of money throughout history up until the 20th century. Shells, cocoa beans, salt, etc. have been used as payment. Salt is important for conservation but also for people in warm countries who sweat a lot and must take in additional salt in the body. In Ethiopia, salt has been used as a mean payment up until the 20th century. Even animals have been used as a measure of wealth and as a means of payment, e.g. camels or reindeer.

Coinage
Even if an agreement could be reached about using raw materials as payment because there was agreement about their value, it isn't always practical to take the raw materials to trading places. Different forms of precious metals therefore became more common. Another additional benefit with metals was that you could shape them, and write their value directly on the coin. This way different types of coins could be exchanged, and the coins took up less space.

Bills
One additional improvement in relation to coinage was the introduction of bills. Bills were even lighter to transport and became cheaper to produce over time. Over the course of history, it was also clear that the bills could be exchanged for coinage and the name on the bills referred to the coinage. Pound sterling, for example, refers to silver coins.

Digital money
However, you also need to carry bills with you. Digital money has a major advantage when it comes to large amounts of money. Most private people today have only a fraction of their money in the form of bills and coins, while the majority of their money is stored as zeros and ones in banks and financial institutions.

Derivatives of money
The largest amount of "money" today, however, is not actually money, rather agreements about different types of payments related to the underlying money, in financial language, derivatives such as options, futures, swaps, etc.

Trust is increasingly important

When money has less value, the importance of trust increases. Raw materials and precious metals have a use for the holder, but zeros and ones in a bank account don't have any value unless that value is granted by someone else. They only have a value if other actors have trust that they represent a value. In most cases, it is the central banks that stand behind as a guarantee of the value. There are also, for example, companies that have bonus points, like frequent flyer points that can be seen as a type of currency.

There is a lot of criticism against many central banks around the world, we might too harsh. This may contribute to the fact that digital currencies are of interest to many people, despite their risks, and despite that the field attracts many incompetent and even fraudulent actors. When we talk about digital currencies today, we most often think about cryptocurrencies — in other words, currencies that are not issued by a central bank, but rather which are controlled in a technical system, such as Ether or Bitcoin. In practice, all currencies are digital in the first place. It is possible that state central banks in the future will decide to issue and guarantee cryptocurrencies as well, in other words digital currencies that are controlled by also by a technical system and not just by a legal system. What an increasing number of people see as possible is that blockchain technology will be used for transferring money in the future[13]. All money is currently based on trust, and whether or not The Economist made the correct assessment when they called blockchain technology "The Trust Machine", it sounds completely plausible. At the same time, it is important to remember that this project is not dependent on crypto-currencies. Coloured coin technology, as explained in the report above, is one way for an organization such as the Lantmäteriet to allow digital units, regardless whether they are a cryptocurrency or not, to represent something in the physical world, for example, property, mortgage deed, or a promissory note. This technology will most likely be possible in the future, but it is not a prerequisite for the process for real estate transactions that is described in the report.

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3. http://www.economist.com/news/leaders/21677198-technology-behind-bitcoin-could-transform-how-economy-works-trust-machine
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5. Different encryption algorithms generate different digital fingerprints for the same document. If the same encryption algorithm, e.g. SHA256 is used, the fingerprint will be the same.
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8. http://www3.weforum.org/docs/WEF_GAC15_Technological_Tipping_Points_report_2015.pdf
9. http://www.economist.com/news/leaders/21677198-technology-behind-bitcoin-could-transform-how-economy-works-trust-machine
10. This is a simplification of how it works. In reality each participants add a number and run SHA256 on the block with the number. If the result is a hash with a sufficiently low number the computer has proved it has spent energy on guessing and is rewarded with Bitocons and the transaction fees coming from the verifications that wants to be added to the blockchain. This is known as Proof of Work.
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12. Distributed Ledger Technology: beyond block chain. A report by the UK Government Chief Scientific Adviser, December 2015
13. http://www.di.se/artiklar/2016/5/3/anders-borg-bankerna-ar-pa-vag-mot-ett-uberlage/

Contributing organizations

Lantmäteriet

Lantmäteriet produces geographic databases and maps and is charged with helping ensure confidence in the ownership of properties and the long term, sustainable use of Sweden's land and water. Lantmäteriet has roughly 2000 employees across 60 cities. Lantmäteriet's head office is in Gävle.

ChromaWay

ChromaWay are pioneers in blockchain technology and have been several times been ranked as one of the world's leading companies in the field. The company has its main office in Stockholm and employees around the world.

Kairos Future

Kairos Future is an international consulting and analysis company that helps companies understand and shape their future. By analyzing trends and the world around them, as well as innovation and strategies, we help our customers see the big picture. Kairos Future was founded in 1993, our main office is in Stockholm, and we have representatives and partners across the entire globe.