BITCOIN

A Peer-to-Peer Electronic Cash System

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Abstract. A purely peer-to-peer version of electronic cash would allow online payments to be sent directly from one party to another without going through a financial institution. Digital signatures provide part of the solution, but the main benefits are lost if a trusted third party is still required to prevent double-spending. We propose a solution to the double-spending problem using a peer-to-peer network. The network timestamps transactions by hashing them into an ongoing chain of hash-based proof-of-work, forming a record that cannot be changed without redoing the proof-of-work. The longest chain not only serves as proof of the sequence of events witnessed, but proof that it came from the largest pool of CPU power. As long as a majority of CPU power is controlled by nodes that are not cooperating to attack the network, they'll generate the longest chain and outpace attackers. The network itself requires minimal structure. Messages are broadcast on a best effort basis, and nodes can leave and rejoin the network at will, accepting the longest proof-of-work chain as proof of what happened while they were gone.

1. Introduction

Commerce on the Internet has come to rely almost exclusively on financial institutions serving as trusted third parties to process electronic payments. While the system works well enough for most transactions, it still suffers from the inherent weaknesses of the trust based model. Completely non-reversible transactions are not really possible, since financial institutions cannot avoid mediating disputes. The cost of mediation increases transaction costs, limiting the minimum practical transaction size and cutting off the possibility for casual one-time transactions. There is also the cost of customer service needed to mediate disputes and the losses from fraud that cannot be prevented. Users must be careful with their information and are subject to many forms of identity theft. Some fraud is accepted as unavoidable. These costs and uncertainties can be avoided in person by using physical currency, but no mechanism exists to make payments over a communications channel without a trusted party.

What is needed is an electronic payment system based on cryptographic proof instead of trust, allowing any two willing parties to transact directly with each other without the need for a trusted third party. Transactions that are computationally impractical to reverse would protect sellers from fraud, and routine escrow mechanisms could easily be implemented to protect buyers. In these terms, we propose a system that solves the double-spending problem using a peer-to-peer distributed timestamp server to generate computational proof of the chronological order of transactions. The system is secure as long as honest nodes collectively control more CPU power than any cooperating group of attacker nodes.

2. Transactions

We define an electronic coin as a chain of digital signatures. Each owner transfers the coin to the next by digitally signing a hash of the previous transaction and the public key of the next owner and adding these to the end of the coin. A payee can verify the signatures to verify the chain of ownership.

The problem of course is the payee can't verify that one of the owners did not double-spend the coin. A common solution is to introduce a trusted central authority, or mint, that checks every transaction for double spending. After each transaction, the coin must be returned to the mint to issue a new coin, and only coins issued directly from the mint are trusted not to be double-spent. The problem with this solution is that the fate of the entire money system depends on the company running the mint, with every transaction having to go through them, just like a bank.

We need a way for the payee to know that the previous owners did not sign any earlier transactions. For our purposes, the earliest transaction is the one that counts, so we don't care about later attempts to double-spend. The only way to confirm the absence of a transaction is to be aware of all transactions. In the mint based model, the mint was aware of all transactions and decided which arrived first. To accomplish this without a trusted party, transactions must be publicly announced [1], and we need a system for participants to agree on a single history of the order in which they were received. The payee needs proof that at the time of each transaction, the majority of nodes agreed it was the first received.

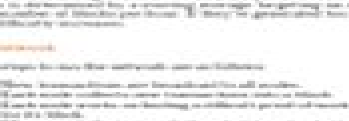
3. Timestamp Server

The solution we propose begins with a timestamp server. A timestamp server works by taking a hash of a block of items to be timestamped and widely publishing the hash, such as in a newspaper or Usenet post [2-5]. The timestamp proves that the data must have existed at the time, obviously, in order to get in the hash. Each timestamp includes the previous timestamp in its hash, forming a chain, with each additional timestamp reinforcing those before it.

4. Proof-of-Work

To implement a distributed timestamp server on a peer-to-peer basis, we will need to use a proof-of-work system similar to Adam Back's Hashcash [6], rather than newspaper or Usenet posts. The proof-of-work involves scanning for a value that when hashed, such as with SHA-256, the hash begins with a number of zero bits. The average work required is exponential in the number of zero bits required and can be verified by executing a single hash.

For our timestamp network, we implement the proof-of-work by incrementing a nonce in the block until a value is found that gives the block's hash the required zero bits. Once the CPU effort has been expended to make it satisfy the proof-of-work, the block cannot be changed without redoing the work. As later blocks are chained after it, the work to change the block would include redoing the work for all blocks after it.



The proof-of-work also solves the problem of determining representation in majority decision making. If the majority were based on one-IP-address-one-vote, it could be subverted by anyone able to allocate many IPs. Proof-of-work is essentially one-CPU-one-vote. The majority decision is represented by the longest chain, which has the greatest proof-of-work effort invested in it. If a majority of CPU power is controlled by honest nodes, the honest chain will grow the fastest and outpace any competing chains. To modify a past block, an attacker would have to redo the proof-of-work of the block and all blocks after it and then catch up and surpass the work of the honest nodes. We will show later that the probability of a slower attacker catching up diminishes exponentially as subsequent blocks are added.

To compensate for increasing hardware speed and varying interest in running nodes over time, the proof-of-work difficulty is determined by a moving average targeting an average number of blocks per hour. If they're generated too fast, the difficulty increases.

5. Network

The steps to run the network are as follows:

1) New transactions are broadcast to all nodes.
2) Each node collects new transactions into a block.
3) Each node works on finding a difficult proof-of-work for its block.
4) When a node finds a proof-of-work, it broadcasts the block to all nodes.
5) Nodes accept the block only if all transactions in it are valid and not already spent.
6) Nodes express their acceptance of the block by working on creating the next block in the chain, using the hash of the accepted block as the previous hash.

Nodes always consider the longest chain to be the correct one and will keep working on extending it. If two nodes broadcast different versions of the next block simultaneously, some nodes may receive one or the other first. In that case, they work on the first one they received, but save the other branch in case it becomes longer. The tie will be broken when the next proof-of-work is found and one branch becomes longer; the nodes that were working on the other branch will then switch to the longer one.

New transaction broadcasts do not necessarily need to reach all nodes. As long as they reach many nodes, they will get into a block before long. Broadcast messages are also tolerant of lost packets. If a node does not receive a block, it will request it when it receives the next block and realizes it missed one.

6. Incentive

By convention, the first transaction in a block is a special transaction that starts a new coin owned by the creator of the block. This adds an incentive for nodes to support the network, and provides a way to initially distribute coins into circulation, since there is no central authority to issue them. The steady addition of a constant of amount of new coins is analogous to gold miners expending resources to add gold to circulation. In our case, it is CPU time and electricity that is expended.

The incentive can also be funded with transaction fees. If the output value of a transaction is less than its input value, the difference is a transaction fee that is added to the incentive value of the block containing the transaction. Once a predetermined number of coins have entered circulation, the incentive can transition entirely to transaction fees and be completely inflation free.

The incentive may help encourage nodes to stay honest. If a greedy attacker is able to assemble more CPU power than all the honest nodes, he would have to choose between using it to defraud people by stealing back his payments, or using it to generate new coins. He ought to find it more profitable to play by the rules, such rules that favour him with more new coins than everyone else combined, than to undermine the system and the validity of his own wealth.

7. Reclaiming Disk Space

Once the latest transaction in a coin is buried under enough blocks, the spent transactions before it can be discarded to save disk space. To facilitate this without breaking the block's hash, transactions are hashed in a Merkle Tree [7] [2] [5], with only the root included in the block's hash. Old blocks can then be compacted by stubbing off branches of the tree. The interior hashes do not need to be stored.

A block header with no transactions would be about 80 bytes. If we suppose blocks are generated every 10 minutes, 80 bytes * 6 * 24 * 365 = 4.2MB per year. With computer systems typically selling with 2GB of RAM as of 2008, and Moore's Law predicting current growth of 1.2GB per year, storage should not be a problem even if the block headers must be kept in memory.

8. Simplified Payment Verification

It is possible to verify payments without running a full network node. A user only needs to keep a copy of the block headers of the longest proof-of-work chain, which he can get by querying network nodes until he's convinced he has the longest chain, and obtain the Merkle branch linking the transaction to the block it's timestamped in. He can't check the transaction for himself, but by linking it to a place in the chain, he can see that a network node has accepted it, and blocks added after it further confirm the network has accepted it.

As such, the verification is reliable as long as honest nodes control the network, but is more vulnerable if the network is overpowered by an attacker. While network nodes can verify transactions for themselves, the simplified method can be fooled by an attacker's fabricated transactions for as long as the attacker can continue to overpower the network. One strategy to protect against this would be to accept alerts from network nodes when they detect an invalid block, prompting the user's software to download the full block and alerted transactions to confirm the inconsistency. Businesses that receive frequent payments will probably still want to run their own nodes for more independent security and quicker verification.

It would be possible to handle coins made up of multiple tokens of smaller denominations. Each token would be transferred as a transaction. To allow users to pay exact amounts, transactions could include multiple output values. Behind the scenes, only a single input or output of each value is needed, but the user wouldn't see it. Incoming transactions would be displayed as a single amount, while the sender's history of the transaction would need to be expanded to select only those needed and those fees would be proportionally small and only need to be paid by the receiver.

9. Combining and Splitting Value

Although it would be possible to handle coins individually, it would be unwieldy to make a separate transaction for every cent in a transfer. To allow value to be split and combined, transactions contain multiple inputs and outputs. Normally there will be either a single input from a larger previous transaction or multiple inputs combining smaller amounts, and at most two outputs: one for the payment, and one returning the change, if any, back to the sender.

It should be noted that fan-out, where a transaction depends on several transactions, which depend on many more, is not a problem here. There is no need to extract a complete standalone copy of a transaction's history.

10. Privacy

The traditional banking model achieves a level of privacy by limiting access to information to the parties involved and the trusted third party. The necessity to announce all transactions publicly precludes this method, but privacy can still be maintained by breaking the flow of information in another place: by keeping public keys anonymous. The public can see that someone is sending an amount to someone else, but without information linking the transaction to anyone. This is similar to the level of information released by stock exchanges, where the time and size of individual trades, the "tape", is made public, but without telling who the parties were.

As an additional firewall, a new key pair should be used for each transaction to keep them from being linked to a common owner. Some linking is still unavoidable with multi-input transactions, which necessarily reveal that their inputs were owned by the same owner. The risk is that if the owner of a key is revealed, linking could reveal other transactions that belonged to the same owner.

11. Calculations

We consider the scenario of an attacker trying to generate an alternate chain faster than the honest chain. Even if this is accomplished, it does not throw the system open to arbitrary changes, such as creating value out of thin air or taking money that never belonged to the attacker. Nodes are not going to accept an invalid transaction as payment, and honest nodes will never accept a block containing them. An attacker can only try to change his own transactions to take back money he recently spent.

The race between the honest chain and an attacker chain can be characterized as a Binomial Random Walk. The success event is the honest chain being extended by one block, increasing its lead by +1, and the failure event is the attacker's chain being extended by one block, reducing the gap by -1.

The probability of an attacker who is currently z blocks behind ever catching up is equivalent to the Gambler's Ruin problem. Suppose a gambler with unlimited credit starts at a deficit and plays potentially an infinite number of trials to try to reach breakeven. We can calculate the probability he ever reaches breakeven, or that an attacker ever catches up with the honest chain, as follows [8]:

p = probability an honest node finds the next block
q = probability the attacker finds the next block
q_z = probability the attacker will ever catch up from z blocks behind

$$q_z = \begin{cases} 1 & \text{if } p \leq q \\ (q/p)^z & \text{if } p > q \end{cases}$$

Given our assumption that $p > q$, the probability drops exponentially as the number of blocks the attacker has to catch up with increases. With the odds against him, if he doesn't make a lucky lunge forward early on, his chances become vanishingly small as he falls further behind.

We now consider how long the recipient of a new transaction needs to wait before being sufficiently certain the sender can't change the transaction. We assume the sender is an attacker who wants to make the recipient believe he paid him for a while, then switch it to pay back to himself after some time has passed. The recipient will be alerted when that happens, but the sender hopes it will be too late.

The recipient generates a new key pair and gives the public key to the sender shortly before signing. This prevents the sender from preparing a chain of blocks ahead of time by working on it continuously until he is lucky enough to get far enough ahead, then executing the transaction at that moment. Once the transaction is sent, the dishonest sender starts working in secret on a parallel chain containing an alternate version of his transaction.

The recipient waits until the transaction has been added to a block and z blocks have been linked after it. He doesn't know the exact amount of progress the attacker has made, but assuming the honest blocks took the average expected time per block, the attacker's potential progress will be a Poisson distribution with expected value:

$$\lambda = z \frac{q}{p}$$

To get the probability the attacker could still catch up now, we multiply the Poisson density for each amount of progress he could have made by the probability he could catch up from that point:

$$\sum_{k=0}^{\infty} \frac{\lambda^k e^{-\lambda}}{k!} \cdot \begin{cases} (q/p)^{(z-k)} & \text{if } k \leq z \\ 1 & \text{if } k > z \end{cases}$$

Rearranging to avoid summing the infinite tail of the distribution...

$$1 - \sum_{k=0}^{z} \frac{\lambda^k e^{-\lambda}}{k!} \left(1 - (q/p)^{(z-k)}\right)$$

Converting to C code...

```
#include <math.h>
double AttackerSuccessProbability(double q, int z)
{
    double p = 1.0 - q;
    double lambda = z * (q / p);
    double sum = 1.0;
    int i, k;
    for (k = 0; k <= z; k++)
    {
        double poisson = exp(-lambda);
        for (i = 1; i <= k; i++)
            poisson *= lambda / i;
        sum -= poisson * (1 - pow(q / p, z - k));
    }
    return sum;
}
```

Running some results, we can see the probability drop off exponentially with z.

```
q=0.1   P=1.0000000
q=0.2   P=1.0000000
q=0.3   P=1.0000000
q=0.4   P=1.0000000
q=0.5   P=1.0000000
q=0.6   P=1.0000000
q=0.7   P=1.0000000
q=0.8   P=1.0000000
q=0.9   P=1.0000000
q=1.0   P=1.0000000

z=0     P=1.0000000
z=1     P=0.2045873
z=2     P=0.0509779
z=3     P=0.0131722
z=4     P=0.0034552
z=5     P=0.0009137
z=6     P=0.0002428
z=7     P=0.0000647
z=8     P=0.0000173
z=9     P=0.0000046
z=10    P=0.0000012
```

Solving for P less than 0.1%...

```
P < 0.001
q=0.10  z=5
q=0.15  z=8
q=0.20  z=11
q=0.25  z=15
q=0.30  z=24
q=0.35  z=41
q=0.40  z=89
q=0.45  z=340
```

12. Conclusion

We have proposed a system for electronic transactions without relying on trust. We started with the usual framework of coins made from digital signatures, which provides strong control of ownership, but is incomplete without a way to prevent double-spending. To solve this, we proposed a peer-to-peer network using proof-of-work to record a public history of transactions that quickly becomes computationally impractical for an attacker to change if honest nodes control a majority of CPU power. The network is robust in its unstructured simplicity. Nodes work all at once with little coordination. They do not need to be identified, since messages are not routed to any particular place and only need to be delivered on a best effort basis. Nodes can leave and rejoin the network at will, accepting the proof-of-work chain as proof of what happened while they were gone. They vote with their CPU power, expressing their acceptance of valid blocks by working on extending them and rejecting invalid blocks by refusing to work on them. Any needed rules and incentives can be enforced with this consensus mechanism.

References

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Bitcoin A Peer To Peer Electronic Cash System

Brett Scott

Bitcoin A Peer To Peer Electronic Cash System:

Bitcoin, a Peer-to-peer Electronic Cash System Satoshi Nakamoto,2008 A purely peer to peer version of electronic cash would allow online payments to be sent directly from one party to another without going through a financial institution Digital signatures provide part of the solution but the main benefits are lost if a trusted third party is still required to prevent double spending We propose a solution to the double spending problem using a peer to peer network The network timestamps transactions by hashing them into an ongoing chain of hash based proof of work forming a record that cannot be changed without redoing the proof of work The longest chain not only serves as proof of the sequence of events witnessed but proof that it came from the largest pool of CPU power As long as a majority of CPU power is controlled by nodes that are not cooperating to attack the network they ll generate the longest chain and outpace attackers The network itself requires minimal structure Messages are broadcast on a best effort basis and nodes can leave and rejoin the network at will accepting the longest proof of work chain as proof of what happened while they were gone **Industry Use Cases on Blockchain Technology Applications in IoT and the Financial Sector** Mahmood, Zaigham,2021-03-18 Blockchain technology presents numerous advantages that include increased transparency reduced transaction costs faster transaction settlement automation of information increased traceability improved customer experience improved digital identity better cyber security and user controlled networks These potential applications are widespread and diverse including funds transfer smart contracts e voting efficient supply chain and more in nearly every sector of society including finance healthcare law trade real estate and other important areas However there are challenges and limitations that exist such as high energy consumption limited scalability complexity security network size lack of regulations and other critical issues Nevertheless blockchain is an attractive technology and has much to offer to the modern day industry Industry Use Cases on Blockchain Technology Applications in IoT and the Financial Sector investigates blockchain technology s adoption and effectiveness in multiple industries and for the internet of things IoT based applications presents use cases from industrial and financial sectors as well as from other transaction based services and fills a gap in this respect by extending the existing body of knowledge in the suggested field While highlighting topics such as cybersecurity use cases and models for blockchain implementation this book is ideal for business managers financial accountants practitioners researchers academicians and students interested in blockchain technology s role and implementation in IoT and the financial sector Cryptocurrency Regulation Immaculate Dadiso Motsi-Omoijiade,2022-06-16 This work argues that current cryptocurrency regulation particularly in the areas of enforcement and compliance is inadequate It proposes reflexive regulation as an alternative approach This book provides strategies for a reflexive regulation approach to cryptocurrencies developed through the identification of the internal self regulatory mechanisms of the cryptocurrency system Apportioning blame for current problems to the regulators failure to take into account the inherent technical features of cryptocurrencies the work promotes

reflexive regulation in which the law acts at a subsystem specific level to install correct and redefine democratic self regulatory mechanisms It provides strategies for this approach developed through the identification of the internal self regulatory mechanisms of the cryptocurrency system These are identified as imbedded in the technical functionality of computer code and consensus based distributive governance mechanisms respectively In addition to providing a technical historical and legal overview of cryptocurrencies the book concludes by providing recommendations aimed at redirecting code and consensus towards achieving regulatory goals In this way it draws from the theory of reflexive law in order to provide both a substantive and jurisprudential perspective on the regulation of cryptocurrencies and to illustrate how Financial Technology Fintech regulation can only be effective once regulators consider both the Fin and the tech in their regulatory approaches The book will be of interest to researchers academics and policy makers working in the areas of Financial Regulation and Jurisprudence Financial Crime Banking Regulation Information Systems and Information Technology The Rise and Development of FinTech Robin Teigland,Shahryar Siri,Anthony Larsson,Alejandro Moreno Puertas,Claire Ingram Bogusz,2018-02-15 This comprehensive guide serves to illuminate the rise and development of FinTech in Sweden with the Internet as the key underlying driver The multiple case studies examine topics such as the adoption of online banking in Sweden the identification and classification of different FinTech categories process innovation developments within the traditional banking industry and the Venture Capital VC landscape in Sweden as shown through interviews with VC representatives mainly from Sweden but also from the US and Germany as well as offering insight into the companies that are currently operating in the FinTech arena in Sweden The authors address questions such as How will the regulatory landscape shape the future of FinTech companies What are the factors that will likely drive the adoption of FinTech services in the future What is the future role of banks in the context of FinTech and digitalization What are the policies and government initiatives that aim to support the FinTech ecosystem in Sweden Complex concepts and ideas are rendered in an easily digestible yet thought provoking way The book was initiated by the IIS the Internet Foundation in Sweden an independent organization promoting the positive development of the Internet in the country It is also responsible for the Internet s Swedish top level domain se including the registration of domain names and the administration and technical maintenance of the national domain name registry The book illustrates how Sweden acts or does not act as a competitive player in the global FinTech arena and is a vital addition to students and practitioners in the field **Bitcoin and Cryptographic Finance. Technology, Shortcomings and Alternative Cryptocurrencies** Lukas Leys,2017-12-06 Designed by an anonymous creator Bitcoin is an intriguing and revolutionary modern technology and payment transaction infrastructure But as with any new technology there are many obstacles and threats on the path towards mainstream acceptance What are the shortcomings of the Bitcoin protocol and Bitcoin as a currency Moreover which competitors may one day be able to surpass Bitcoin and make it obsolete Could a suitable competitor replace Bitcoin or will the open source

virtual currency keep improving itself to make competition obsolete Traditional classifications for currencies do not adequately apply to Bitcoin It is a new type of financial technology that entered the global market in 2008 and has since been able to draw the attention of investors business leaders regulators and politicians Whereas a Dollar Yen Yuan or Euro can be hold like a currency they cannot be secured and transacted simply by itself Individuals have to rely on third party intermediaries in order to transfer funds for them and in order to store them securely Contrary to that one cannot focus on Bitcoin as a currency without acknowledging that it is also a transaction system in itself and would not be able to function is one part of this duality is gone In fact it is even more precise to look at Bitcoin as a decentralized transaction and financial services system with a currency function being only one aspect of the technology In this book Bitcoin Ripple cryptocurrency financial technology financial service virtual currency *E-Commerce* Zheng Qin,Qinghong Shuai,Guolong Wang,Pu Zhang,Mengyu Cao,Mingshi Chen,2022-11-07 This book mainly discusses the background of e commerce the basic knowledge of e commerce the basic models of e commerce the basic principles of e commerce and the cases of e commerce This book has formed a theoretical system of e commerce with a clear integration boundary The introduction of the systematic theory is guided by the background of e commerce centered on the model of e commerce paved with the principles of e commerce and integrated with the cutting edge cases This book defines the basic concepts models and principle of e commerce in the form of mathematical analysis and analyzes the basic theory of e commerce from the perspective of mathematical model This enables readers to form an abstract understanding of the connotation and extension of e commerce It establishes a knowledge system with the background of social ecology engineering ecology and innovative ecology taking the models of e commerce as the core the principles of e commerce as the process the architecture of e commerce as the platform and the operation and management of e commerce as the means to integrate the knowledge into application This book uses case study to comprehensively analyze and apply the knowledge system involved in e commerce combining theoretical research with engineering research Through this book readers can systematically master all kinds of theories involved in e commerce This book aims at different professional and diverse reader groups It can be used as the basic books for students of various e commerce related specialties Bitcoin Whitepaper Mylittlewhitepaper,2022 Bitcoin whitepaper **Cloudmoney** Brett Scott,2022-07-05 Axiom Award Gold Medalist for Business Commentary The reach of Corporations into our lives via cards and apps has never been greater many of us rarely use cash these days But what we re told is a natural and inevitable move is actually the work of powerful interests And the great battle of our time is the battle for ownership of the digital footprints that make up our lives In Cloudmoney Brett Scott tells an urgent and revelatory story about how the fusion of Big Finance and Big Tech requires cloudmoney digital money underpinned by the banking sector to replace physical cash He dives beneath the surface of the global financial system to uncover a long established lobbying infrastructure an alliance of partners waging a covert war on cash He explains the technical political and cultural differences

between our various forms of money and shows how the cash system has been under attack for decades as banking and tech companies promote a cashless society under the banner of progress Cloudmoney takes us to the front lines of a war for our wallets that is also about our freedom from marketing strategies against cash to the weaponization of COVID 19 to push fintech platforms and from there to the rise of the cryptocurrency rebels and fringe groups pushing back It asks the most pressing questions Who benefits from a cashless society and who gets left behind Is the end of cash the end of true privacy And is our cloudmoney future closer than we think it is **Applied Cryptography and Network Security** Ioana Boureanu,Philippe Owesarski,Serge Vaudenay,2014-06-05 This book constitutes the refereed proceedings of the 12th International Conference on Applied Cryptography and Network Security ACNS 2014 held in Lausanne Switzerland in June 2014 The 33 revised full papers included in this volume were carefully reviewed and selected from 147 submissions They are organized in topical sections on key exchange primitive construction attacks public key cryptography hashing cryptanalysis and attacks symmetric cryptography network security signatures system security and secure computation Valuation of Crypto Assets. A Conceptual Framework and Case Application to the IOTA Token Abdulkarim Ajouaou Saidi,2019-08-09 Master s Thesis from the year 2018 in the subject Business economics Controlling grade 2 0 Berlin School of Economics and Law language English abstract This thesis aims at elaborating fundamental valuation techniques for crypto assets Since research in this field is still at the very beginning this work intends to provide investors financial analysts token issuers researchers or crypto enthusiasts a framework of how to determine the fundamental value of this emerging asset class To do so three main research questions are formulated 1 How can the fundamental value of crypto assets be determined 2 Which valuation techniques can be applied to the different token types 3 What is the fundamental value of the IOTA token In order to answer the questions the thesis will progress in the following manner First the reader will be introduced to distributed ledger technology DLT and blockchain which represent the underlying technology of crypto assets In the next step the term crypto asset will be defined It will be elaborated to what extent crypto assets can be considered as a new asset class and how crypto assets can be classified into different types The terminological part will end up with a discussion of the fundamental value of this new asset class The main body of the thesis consists of two parts a theoretical conceptual and a practical applicational part The theoretical part aims to collect and evaluate all current valuation methods for crypto assets Different absolute as well as relative valuation techniques will be elaborated namely the Discounted Cash Flow DCF model and CAPM the asset rotation theory the Equation of Exchange the NVT ratio Metcalfe s Law the cost of production approach as well as the accessibility discount The second part of the main body comprises a case application of one valuation model namely the Equation of Exchange to the IOTA token *The Impact of Blockchain Technology on Capital Markets. A Transformation of our Financial System?* Dominik Campanella,2018-09-25 Blockchain technology could change our financial sector forever The digital distributed database is perceived as a focal point in the emerging FinTech sector and it is only at its beginning The

disruptive potential on the capital markets is undeniable since it already influenced our economy with the cryptocurrency Bitcoin But what kind of structural transformation can we expect Which challenges come with such an innovation And will it work with our existing financial infrastructure Dominik Campanella unearths the truth In his book he identifies potential application fields the uprising technology Campanella evaluates their operational and strategic implications and analyses remaining challenges of the wide adoption of blockchain technology In this book Bitcoin cryptocurrency financial sector innovation digitalization *Cryptostorm* Sundeep Khanna,2023-05-14 The colour of money is changing to crypto With the regulatory environment struggling to keep up there has been prolonged ambivalence on the legality of cryptocurrencies This has led to chaos but has also allowed a few to make unprecedented gains Like all bubbles there is a looming threat of a big bang bust and with stories emerging of people losing lifetimes savings there are serious fallouts that should be considered Even so cryptos are an idea whose time has come That is why no central bank now dares to place a complete and comprehensive ban on them With bitcoin which kicked off this revolution now valued at a trillion dollars and many other virtual currencies worth billions the genie has left the bottle From being agents of chaos cryptos have gone mainstream and regulators are stuck between the proverbial rock and a hard place Before reason and rationality dawn though there will be ferment Of the thousands of cryptocurrencies in existence today only a handful will survive The ones that don t will spell ruin for millions of gullible Indians This the first book on the cryptostorm that is sweeping India reports stories of ordinary people whose lives have been touched and in some cases irrevocably changed by the promise and threat of cryptos The individuals in this book populate a new India They believe they have seen a way to uplift their lives unencumbered by governments and regulators Their voice needs to be heard because it is the sound of tomorrow which we ignore at our own peril Bitcoin. What is its Impact on the Future of Online Commerce? Christopher Schulz,2021-03-08 Pre University Paper from the year 2019 in the subject Computer Sciences Cryptocurrency grade 1 language English abstract In general this paper is going to consist of an explanation of Bitcoins and the Blockchain system followed by the results of the question if Bitcoins could impact the future of online commerce Additionally this paper will exhibit the risks of investing or working in this decentralized trading system To show the procedure of purchasing Bitcoins or other cryptocurrencies I am going to conduct a self experiment and procure a cryptocurrency and document the process of doing so Cryptocurrencies have been causing major public attention for the last few years Especially the most prominent one Bitcoins In between all this internet activity people seem to overlook the real meaning of Bitcoins how they work and how they could be integrated in the economic world as it is right now The goal of this pre scientific paper is to explain the function of Bitcoins reveal it s risks and to elucidate the possibility of Bitcoins making an impact on the future of online commerce by detailed literature and internet research

The History of the Computer Rachel Ignotofsky,2022-05-17 A strikingly illustrated overview of the computing machines that have changed our world from the abacus to the smartphone and the people who made them by the New York Times

bestselling author and illustrator of Women in Science A beautifully illustrated journey through the history of computing from the Antikythera mechanism to the iPhone and beyond I loved it Eben Upton Founder and CEO of Raspberry Pi ONE OF THE BEST BOOKS OF THE YEAR The New York Public Library Computers are everywhere and have impacted our lives in so many ways But who created them and why How have they transformed the way that we interact with our surroundings and each other Packed with accessible information fun facts and discussion starters this charming and art filled book takes you from the ancient world to the modern day focusing on important inventions from the earliest known counting systems to the sophisticated algorithms behind AI The History of the Computer also profiles a diverse range of key players and creators from An Wang and Margaret Hamilton to Steve Jobs and Sir Tim Berners Lee and illuminates their goals their intentions and the impact of their inventions on our everyday lives This entertaining and educational journey will help you understand our most important machines and how we can use them to enhance the way we live You ll never look at your phone the same way again Kritische Analyse von Kryptowährungen. Was sind die Chancen und Risiken der Kryptowährung Bitcoin? F. Warner,2023-06-01 Studienarbeit aus dem Jahr 2021 im Fachbereich BWL Investition und Finanzierung Note 1 3 FOM Hochschule f r Oekonomie Management gemeinn tzige GmbH M nchen fr her Fachhochschule Sprache Deutsch Abstract In dieser Arbeit wird versucht eine kritische Analyse von Kryptow hrungen zu geben Dabei wird besonders auf die Kryptow hrung Bitcoin eingegangen Konkret versucht diese Seminararbeit folgende Fragestellung zu beantworten Was sind die Chancen und Risiken der Kryptow hrung Bitcoin Als vor ber 3000 Jahren die ersten Kulturen begannen mit Geld anstatt mit Rohstoffen zu handeln erleichterte diese nderung den Handel und Erwerb von G tern immens Der Wandel zum Geld machte die Menschheit freier und ihr Handeln mit G tern globaler Denn im Gegensatz zu Rohstoffen ist Geld haltbar leicht transportierbar und kann ber L ndergrenzen hinaus verhandelt werden Die Idee von Geld ist simpel gesprochen Alles kann zu allem werden Geld kann grunds tzlich gegen jeden Gegenstand oder jede Dienstleistung umgetauscht werden Dabei war Geld zu Beginn so viel Wert wie die Sache die daf r eingetauscht wurde Mit dem wachsenden Vertrauen der Menschheit in Geld nderte sich das Denn das gr ne Papier auf dem die Zahl 100 steht ist genau genommen nichts wert Der Wert entsteht nur dann wenn alle es glauben Der Historiker Harari beschreibt dieses Ph nomen als intersubjektive Realit t Das System Geld kann nur bestehen weil die gesamte Menschheit es anerkennt Denn Damit Geld zu Geld wird bedarf es nicht einfach der Einf hrung der Zentralbanken sondern zun chst einem weit wichtigeren Faktor dem Vertrauen Wie abstrakt Geld aber werden kann erf hrt im Oktober 2008 zun chst eine Gruppe weniger Auserw hlter als sie eine Mail von Satoshi Nakamoto erhalten Vorgestellt wird ein neuartiges Zahlungssystem welches dezentral arbeitet keine zentrale Steuerung ben tigt und rein digital ist Alle Teilnehmer k nnen so einfach und sicher zahlen nur dass die W hrung kryptografisch verschl sselt ist Banken und Finanzinstitute macht Nakamoto damit obsolet und revolutioniert damit die bestehenden Standards Die Erfindung die er in dieser E Mail beschreibt ist die Kryptow hrung Bitcoin *Applications of Blockchain in the Automotive Insurance Industry.*

A Model Development from the Perspective of the Service Provider Sector Enrique Gil Ramirez,2020-10-20 Master s Thesis from the year 2018 in the subject Economics International Economic Relations Cologne Business School K ln language English abstract This research has been gathered together with the collaboration of Control Expert Company a German company dedicated to providing services to the core business of the automotive insurance industry This research is mainly focused on the different applications that Blockchain technology offers the automotive insurance industry Based on these applications a process model is developed from the perspective of the service provider sector of the automotive insurance Having the main focus in mind this research will answer the following question How does Blockchain technology benefit the Automotive Insurance Process The structure of this research will lead the reader through the evolution of the Blockchain technology and its features First a full definition of the technology will be explained This will be followed by the generations of Blockchain and its classification After that some history on regards Blockchain and the digital era will be mentioned Such as the main innovations of the digital era the creators of the technologies involved in Blockchain and the main innovations within Blockchain As the Internet of Things has become more and more popular during the last years it is not possible to ignore the huge impact that it is having on people s daily lives IoT represents a network of devices such as sensors vehicles computers and more which interact among themselves and exchange information Here comes a very interesting subcategory of the IoT The Internet of People The Internet of People describes the exchange of data through different devices but related to the people or in other words the information gathered comes strictly from people From this idea the Internet of Money rises describing mainly how Blockchain and Bitcoin are changing the financial system This is based on the idea of recording transactions in a safer way within a more decentralized system Due to the strong disruption of Blockchain within different industries and the usability of the technology it has been considered as an extra layer working over the internet This is a new tier that enables transactions on a different level permitting storage and record of data in a different way than a conventional database Hat Bitcoin die Chance als Zahlungsmittel anerkannt zu werden? ,2024-06-18 Studienarbeit aus dem Jahr 2022 im Fachbereich BWL Sonstiges Note 1 0 Fachhochschule D sseldorf Sprache Deutsch Abstract Das Ziel dieser Arbeit ist es anhand der Gegen berstellung von Chancen und Risiken eine Aussage ber die Zukunft des Bitcoins als Zahlungsmittel zu treffen Methodisch wird folgenderma en vorgegangen Zuerst werden im zweiten Kapitel der Arbeit im Rahmen der theoretischen Grundlagen die Begriffe Zahlungsmittel und Virtuelle W hrung er rtert Dieses soll dabei helfen die Fragestellung richtig zu verstehen Darauf aufbauend wird im dritten Kapitel der Bitcoin im Fokus stehen Hier wird die Historie die Funktionsweise und die Verbreitung des Bitcoins erkl rt Folglich werden im vierten und f nften Kapitel die Risiken und Chancen besprochen Schlie lich wird im letzten Kapitel das Fazit gezogen Im Jahr 1909 wurde das Papiergeld in Deutschland als gesetzliches Zahlungsmittel anerkannt Seitdem ist das Papiergeld ein unverzichtbares Zahlungsmittel f r die Menschen Nun sind wir in einem digitalen Zeitalter angekommen wo schon seit Jahren ber Abschaffung des Papiergeldes

diskutiert wird Es ist m glich dass in der fernen Zukunft M nzen und das Papiergeld komplett aus unserem Alltag verschwindet und alles nur digital abl uft Bereits jetzt werden die 500er Scheine nicht mehr produziert Zudem schreiten weitere Projekte seitens der Europ ischen Zentralbank voran bereits in der nahen Zukunft soll das Bargeld durch den digitalen Euro erg nzt werden Auch die Kryptow hrungen r cken immer mehr in die Schlagzeilen Immer mehr Anbieter akzeptieren eine Zahlung mit der bekanntesten Kryptow hrung den Bitcoin Daraus ergibt sich auch die Fragestellung dieser Arbeit Hat der Bitcoin die Chance als offizielles Zahlungsmittel anerkannt zu werden *Is the consumer willing to adopt the innovative cryptocurrency Bitcoin as a payment method?* Liutauras Rokas,2020-04-28 Master s Thesis from the year 2019 in the subject Computer Sciences Cryptocurrency grade 2 7 course INNOVATION AND TECHNOLOGY MANAGEMENT language English abstract Is the consumer willing to adopt the innovative blockchain based cryptocurrency Bitcoin as a payment method The aim of this work is to assess the European consumer s intention to use Bitcoin for payments Bitcoin is not yet defined in many ways The Role of the consumer is important as consumers play a significant role in technology adoption In this work Bitcoin is investigated from the consumer s perspective as an available innovative payment method A literature reviewed allowed characterizing Bitcoin and to outline factors that have an effect on the consumer s intention to adopt this innovative technology for payments These factors compatibility as in Innovation Diffusion Theory and perceived risk were integrated with a theoretical research model Technology Acceptance Model and its constructs perceived ease of use perceived usefulness and behavioral intention in order to predict the consumer s intention to use Bitcoin for payments The proposed model was empirically tested using data collected from a survey of European consumers The Structural Equation Modeling SEM technique was used to evaluate this research model and a Confirmatory Factor Analysis CFA was performed to test the reliability and validity of the proposed measurement model Risk Management for Investment Funds: A Practical Guide for European Funds in International Markets Luc Neuberg,François Petit,Martin Vogt,Paul Kleinbart,2023-02-14 The first comprehensive risk management guide to European investment funds The European investment fund market is one of the biggest financial markets in the world with a total value of approximately 22 trillion EUR To help investors understand how risk is managed in this vast market Risk Management for Investment Funds provides a comprehensive yet practical guide written by four financial experts from diverse and complementary backgrounds former heads of risk management university teachers professional trainers and an expert with a supervisory financial authority Risk Management for Investment Funds offers valuable insights into managing risk for UCITS funds and alternative investment funds while covering the following aspects The framework of European investment funds Regulatory requirements related to risk management that apply to funds and fund managers Traditional market liquidity credit counterparty and operational risks faced by funds their managers and investors Emerging risks related to climate change and technology Analytical methods and innovative techniques developed by successful risk managers to assess and manage risks as well as the theories

underlying them Packed with a wealth of information that cannot be found in other books on risk management this authoritative guide to managing the risks of European funds is the most comprehensive publication on this important topic

Kryptowährungen als Gefahr für die Währungshoheit? Romaeus Hover,2020-06-17 Bachelorarbeit aus dem Jahr 2019 im Fachbereich VWL Geldtheorie Geldpolitik Note 1 7 Universit t der Bundeswehr M nchen Neubiberg Sprache Deutsch Abstract Das Ziel dieser Arbeit ist es einen berblick ber die vorhandene Literatur zu geben sowie potentielle Entwicklungsm glichkeiten der Kryptow hrungen darzustellen Die Arbeit soll zeigen welche Gefahren f r die W hrungshoheit existieren und wie realistisch diese sind Ferner soll aufgezeigt werden welche Einfl sse die Gefahren vergr ern k nnen sowie welche Entwicklungen der Kryptow hrungen die Gefahr erh hen k nnten Diese potentielle Gefahr besteht nicht nur f r den Euroraum sondern auch f r andere W hrungsr ume Die Analyse bezieht sich dabei jedoch nur auf den Euroraum da der Euro zu den weltweit st rksten W hrungen z hlt Falls Kryptow hrungen eine Gefahr f r den Euro darstellen k nnten w rde dies ein deutlich gr eres Gefahrenpotential f r die Zentralbanken schw chere W hrungen implizieren Die Betrachtung von den potentiellen Gefahren f r diese Zentralbanken w rde zu einer Verzerrung der Ergebnisse f hren Um das Ziel der Arbeit zu erreichen wurde berwiegend Literatur verwendet die im Gros nicht lter als zwei Jahre ist um so eine m glichst hohe Aktualit t der Ergebnisse gew hrleisten zu k nnen ltere Literatur wurde verwendet um Definitionen und Modelle zu erl utern Das Ergebnis der Arbeit ist dass Kryptow hrungen in ihrer jetzigen Form keine akute Gefahr f r die W hrungshoheit der EZB darstellen Dies deckt sich mit den Befunden der restlichen Literatur und mit der eigenen Einsch tzung der EZB Durch externe Faktoren oder durch die technische Weiterentwicklung der aktuellen Kryptow hrungen kann das Risiko jedoch steigen dass der Euro an Relevanz verliert Durch den Verlust der Relevanz des Euros k nnten Kryptow hrungen auf l ngere Betrachtung damit eine Gefahr f r die W hrungshoheit der EZB darstellen

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