Michael Merz

Blockchain for B2B Integration

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Technologies, Applications and Projects

Michael Merz

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Table of Contents

Prologue

75XBOBBY99 wanted to take an abbreviation to Saratoga when a convoy of other robocars blocked him. He had not expected that so many robocars – including from Mountain View – would come here. On this morning, this could really indeed screw up his charging slot.

His ICO was already seven months ago and, for four months, 75XBOBBY99 drove multiple times per week to Saratoga. His holders had already benefitted financially quite well with their investment. Overall, there were 476 accounts. Sometimes, one sold, sometimes one came on-board – but, all in all, it concerned a rather manageable number of investors. 75XBOBBY99s market capitalization was approx. 2,365 Enercoins – for a robocar that was seven months old, not phenomenal, but still quite okay.

It transported his owner in the morning to the dentist. However, the appointment was set for 9:00 a.m. so that 75XBOBBY99 had to select another route to Saratoga due to this later time. Despite the distance from San Jose, Saratoga was in the morning the best location for charging because the electricity was supposed to be at zero cost the entire day there. During the night, it had stormed. Thus, even the last-ditch lead batteries in the region were charged to the brim. All electrolyzers around were already running at full blast and there had still been five storm-force winds from the Northwest forecast until midday.

Solely this column from Mountain View upset his plans – excessive demand was detrimental to the prices and 75XBOBBY99 could also miss his slot! For a few days, he used charging stations at a wind farm which was located somewhat outside of Saratoga. Today, however, he had to spontaneously reserve a new charging slot because the dentist's appointment had unexpectedly come up. Fortunately, he had been able to sell his original slot for 7:50 a.m. at a minimal loss to 75XXXJULIAD on the intraday market.

For 75XBOBBY99, the highest goal was to supply his holders with a reasonable yield. In addition, this also included decisions such as on this morning: To trade slots on short notice and, in so doing, to collect the greatest possible number of Enercoins. And then to drive somewhat farther in order to charge up the batteries there. The direct tapping of the wind farms offered the big advantage that the electricity could be procured at minimal prices – thus no grid usage fee, no surcharges, no levies, only the VAT on almost nothing. For this, 75XBOBBY99 had even recently had his battery capacity extended.

Previously, the wind farms had to always be turned off if they produced too much – back then, they called this "generation-side management" quite euphemistically. Actually, one should have called this measure "capital destruction". At that time, the electricity couldn't be transported away by the grids because they simply weren't designed for decentralized electricity production. It had long been pondered whether the grids should be expanded. However, this would have cost umpteen million Enercoins (at that time, during the time of the Fiat currencies, this was more than 50 billion Dollars). But why instead not just bring the batteries to the grid congestions wherever they also occurred? Vehicles were often just idly standing around! In this regard, these days, each change in the weather forecast immediately results in a change in the road traffic. One could set one's watch by it: As soon as an updated weather forecast announced wind of more than 15 mph, the Autobahns were jammed up going out of the cities in less than ten minutes.

The few people who still drove themselves had thus become accustomed to see empty robocars around them everywhere in a traffic jam whenever they rolled out into the countryside like an avalanche. Initially, one had actually considered inflating plastic dolls to be placed in the driver's seat so that people wouldn't feel that they had been abandoned on the roads, but since robocars at some point had no more driver's seats, the idea was shelved.

In the meantime, 75XBOBBY99 promptly reached Saratoga. He docked at a charging station and stayed here for four hours. The electricity sufficed until the weekend and, during the course of the day, he was able

to still make a couple of paid trips until he would pick up his owner once again from the office around 6:00 p.m.

1 Foreword

Blockchain! One almost doesn't want to hear this term anymore because everybody is so often talking about a technology which is frequently misunderstood, superelevated and, at the same time, underestimated. Around the year 2013, the international blockchain community began to expand from the nerd and crypto scene to the application fields in the financial industry, the energy sector and many other industries. This then dovetailed with a constantly-increasing superelevation of the technology.

The blockchain was propagated as the problem-solver for simply everything – optimally still with an admixture of artificial intelligence and big data. Because this notion had already continued to be constantly intensified, I made the attempt to describe the "blockchain" phenomenon from the most neutral, agnostic perspective possible and to show the possibilities and the limitations of the technology. Ultimately, this book was the result.

On the Internet, there are already a large number of sources regarding the theme, based upon which one can create a good knowledge base. In addition, conferences are held upon a regular basis in every larger city and YouTube has an abundance of videos which explain how the blockchain functions. Why then still write another book on this theme?

This book carries the title "Blockchain for B2B Integration" – this means firstly that we will address the theme of "blockchain" *from a technical perspective*. Secondly, we will analyze the *B2B* processes from an industry's perspective in order to concretely show which applications possibilities exist and what in detail must be kept in mind. In this case, the energy sector serves merely as a placeholder for many additional industries in which business processes run which encompass a large number of business partners. Based upon project examples, it is supposed to ultimately be shown which processes can be supported particularly well by the blockchain and why.

A comprehensive analysis, starting with the technology and extending to its application will help the reader to go a step farther and to learn from these projects and experiences, based upon experiences with consortia such as Enerchain, NEW 4.0, Gridchain, or ETIBLOGG.

For classification purposes

Thus, I wrote this book because the niche of "blockchain for B2B integration" has only an insufficient number of practical examples. Admittedly, it is also a difficult

1 **Foreword**

niche because worlds lie between desk work, quickly-programmed smart contracts and actual operations precisely in the "blockchain" segment. In addition, there is also the fact that production operations are only then beginning.

The already-existing abundance of blockchain books explains the theme either technically or on the level of "management literature". In so doing, each author has his own perspective on the theme. It is like the good old example of the elephant in the dark room which several persons feel and try to describe: It is at the same time a garden hose, leaf, string, tree stump, dagger, leather strap, etc. Book authors also approach the blockchain from various perspectives: There are very good books which address in very detailed fashion even the program code level of Bitcoin. I myself use the books from Andreas Antonopoulos (e.g. [Anto17]) for reference purposes when I truly want to understand all the details of Bitcoin. Whoever would like to can obtain an overview per the "management literature" á la Tapscott & Tapscott [TaTa16]. Many additional publications illuminate the theme of "blockchain" in detailed fashion from additional perspectives – they emphasize the disruption potential or new possibilities for the company to envision processes decentrally. Once again, others place a focus on the area of innovative business processes and list off popular examples in this regard (electronic land register, traceability in the supply chain, sustainability certification for the manufacturing of consumer products, etc.). In this regard, the technical portion is frequently neglected and one loses the feeling of whether these processes are then truly implementable subject to the consideration of all real circumstances. There is a substantial gap between programming a prototype and actually using blockchain technology. Thus, it is important with regards to blockchain processes to keep an eye on linking the application to the technology and to repeatedly scrutinize their interaction because the hard challenges only then reveal themselves during the final sprint.

There is also still an additional perspective on the theme of "blockchain" – namely the perspective of the skeptic. At this juncture, I would like to likewise recommend such a book because it is gladly ignored within the community that the utilization of the blockchain doesn't always make sense: "Attack of the 50-Foot Blockchain" from David Gerard [Gera17]. I met David at a conference in London and he has, politely expressed, unmasked many blockchain features which the crypto scene has to offer as still very premature: – from Bitcoin to smart contracts, DAOs, ICOs even to B2B blockchains. In his book, he addresses a large number of deficiencies, problems, misunderstandings, transfigurations, misconceptions and scandals. David is thus a proven blockchain contrarian and it was very exciting to debate with him. If you thus are a professed blockchain enthusiast, please absolutely also endure David's book and come down to earth! It doesn't benefit anyone to dream of a usage of the

technology whereby important characteristics are neglected and which can then create no added value – in the worst case, the result would only then be "money down the drain".

Why then this book?

If, despite the 50-foot blockchain, you still have an interest in reading this book – what can I offer you? The purpose of this book is to implement an elevator trip based upon Figure 1 – from the basements of technology to the boardroom and back again. And upwards again and back and this still a couple of more times. "Blockchain" can be understood best of all if the reader is familiar with both levels and feels "at home" both up above and down below. Then the elevator trip is fun and one enters into the "flow" of designing something really new. This elevator trip in the B2B environment confronts us repeatedly with the situation of analyzing old business processes in a new light or even designing new processes which can disturb old roles and rules. Because this is an inspiring activity, the focus of this book will be on using the blockchain for B2B integration.

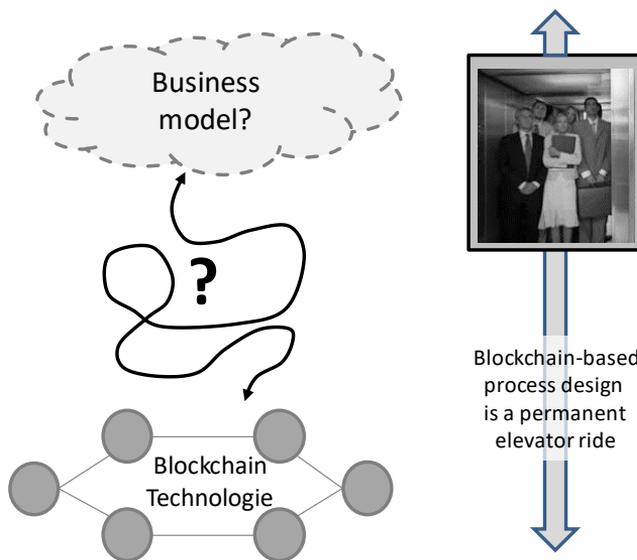*Figure 1: Blockchain Projects Require A Frequent Change in Perspective*

Thus, through this book, I would like to dare to illuminate quite different thematic focuses at the same time. Both the technology, but also the application are to be covered. Because my company is active particularly for the energy industry, I ask that the reader forgive me that I have placed the business focus precisely there. This

hopefully will also help energy laypersons to understand the pros and cons within this sector's context and to transfer them to the processes in one's own environment.

Moreover, I have also attempted to present other projects, in which we ourselves are not involved, for this book, but the problem still existed in most cases that one could hardly obtain detailed information behind the marketing veil. Often, these projects also terminated in an early prototype phase. In this regard, I offer my thanks to the protagonists from StromDAO with whom I was able to develop a deeper understanding for their technology in a very detailed conversation. If additional details regarding other projects should be created in this regard in the future, I will naturally include such projects in Chapter 6 in later editions.

The thematic field of "blockchain" has in the meantime now become so differentiated that this book will largely exclude presenting the wide array of cryptocurrencies: one could discuss here in detail the special characteristics of DASH, Zcash, NEO, etc. as well as also discuss their history, tools and possibilities to trade them or everything which can befall a cryptoinvestor using crypto. In this regard, one can find interesting publications such as, for example, [Hosp17]. Likewise, issues regarding crypto exchanges, the investment in tokens, ICOs, STOs, or advices how get involved in mining are not in the forefront in this book.

Blockchain for B2B integration

Under a *B2B blockchain*, I understand a business to business integration technology which is specially customized to the requirements of industrial consortia and, for this, uses blockchain mechanisms such as immutability, consensus-building, 1:N communication upon the basis of cost-effective, redundant nodes for efficient coordination.

B2B blockchains thus offer the opportunity to optimize or replace existing business processes. Accordingly, the influence is disruptive on the organization of the commercial interaction. However, blockchain projects in the industry are frequently implemented behind closed doors – thus, noisy marketing is not required beyond sector boundaries. The goal for such projects lies in process optimization and not in the broad publication of the results.

However, industry consortia are repeatedly confronted with similar issues regardless of which industry they belong to: "Is 'blockchain' suitable for our business process?", "Is it beneficial to adapt our process to the blockchain?" or "Can we possibly find a completely different process which much better utilizes the blockchain's potential?". And then additional questions arise: "How do we want to organize the blockchain?", "How do we want to organize ourselves?", "How much centralization do we nonetheless still need at the end without reverting back to the world of old processes?".

"What will the regulator or the lawmaker say about our approach?", "How can we prevent a (new) monopolist from sneaking in through the backdoor?", "Who will be the winners and the losers with the new process?" – questions and more questions!

Based on the project examples from the energy sector and specifically from energy trading, such issues are supposed to be illuminated in this book.

What is the problem for the solution?

A difficulty afflicting blockchain projects entails the varying allocation of expert know-how. Whoever intends to do a blockchain project must understand the technology *and* the process to be implemented. However, this is no linear process, but rather requires a change of perspective upon a regular basis. Sometimes, the technology is the starting point for the analysis: "How can we utilize the high availability, trustlessness and lower operational costs to our benefit?" Sometimes, the technical requirements are the focus: "How can I allow the customers to participate in the process without violating the data protection laws?"

With regards to "classical" IT projects, the "business case" is the focus which encompasses one's own company as the driver of a development. A new solution must be implemented, a process must be designed to be more efficient, an application must be developed which is supposed to fulfil the new external or internal requirements. From this, a plan and a set of specifications are created which are then implemented by the traditional waterfall model for software development or iteratively. Tools and processes are sought out in such a manner that the software to be developed optimally fulfils the requirements. Naturally, with regards to these "classical" projects, during the operational phase as well, the corresponding performance requirements are implemented in such a manner that the highest-possible quality is attained. Everything "in time, in budget, in quality" – naturally as always… In each case, however, the solution follows the problem.

And now there is this blockchain technology! Everybody wants to develop something with it and try this out for themselves in order to see whether the goal can also not be attained with this new technology in a faster, better and more disruptive manner. The management wants to proclaim that its own company can do "blockchain". IT colleagues want to play around with the technology and try out its possibilities while others see an opportunity to enhance their resume with an attractive theme.

But the blockchain has a problem: It is not particularly adaptable technically. In contrast to an SQL database, its technical "wiggle room" is rather limited. It is indeed not even a database! And data worthy of protection can also not be stored in it without further effort. And then there is also still the waiting period until a consensus is

reached or the question which arises regarding where the many nodes are supposed to be installed then at all – and why all of this when actually only the good old club administration system is supposed to be updated?

Thus, it would make no sense technically to plug the blockchain simply under the classical application design for the development of a club administration system. For marketing purposes, this perhaps makes sense, but the administrator who is responsible for the system operation would probably immediately quit. Thus, a prototype remains which can however be used to at least still produce a blockchain-operated club administration system and, through this innovation, the market capitalization of one's own company may increase…

Thus, the blockchain is not a solution for a vast number of problems.

Developing a blockchain application which is actually sensible is much more difficult: It is like being the answer to a question which must still be formulated. It is a solution for a problem which has not yet even been identified at all. In many cases, one can only create new business model by keeing an eye on the possibilities and the restrictions of the blockchain. And even more difficult: One must abandon the platform of one's own company in order to seek out possible applications from the helicopter perspective. Consequently, it must be accepted that one's own company organisation will be only a "cog in the wheel" of the future process. Thus, it is better for a person to be an economist than a business manager in order to discover the global benefits of the technology.

This once again requires even more so the close cooperation between technical blockchain experts and business innovators who listen to one another and jointly "explore new territory". Such an approach is frequently even demanded by innovation managers. Countless terms and seminars exist for this, but, nevertheless, this is no "walk in the park". This approach is similar to a permanent elevator ride starting in the basement of cryptography, then going to the parking level of distributed software systems, the lower floors of the company processes, and finally to the executive management floor of the cross-industry transformation of processes and markets. Accordingly, many know-how carriers must be synchronized because individual persons who have simultaneously mastered all knowledge fields are indeed rare.

Content overview

In this book, thus such an elevator trip is supposed to be implemented across all relevant floors:

- "Blockchain" evokes myths and misunderstandings, some of which I would like to clarify in *Chapter 2*. Hopefully, this will at the same time create an appetite for the rest of the book.
- In *Chapter 3*, the technical foundation of blockchain is explained – sometimes based on Bitcoin because it is the mother of all blockchains, the best-understood and the best-documented, but sometimes also upon the basis of technologies which are more relevant for industry consortia.
- The non-technical focus of this book lies in the area of consortia blockchains. In this regard, it illustrates some application which industry consortia are implementing today and will be implementing in the future as well. In order to better understand these application cases in the context of a specific industry, *Chapter 4* provides a thorough overview of current developments in the energy sector and how it will change over the long term as a result of the energy transition.
- After the range of the elevator trip has been set between the technological solution and the energy transition requirements, it will be examined in *Chapter 5* how inter-company processes can be supported via the blockchain and what requirements this poses for the consortia.
- *Chapter 6* presents typical blockchain projects from research and practical application with an energy transition background and which leads the visions of "Scenario 2030" in Chapter 4 towards realization.
- *Chapter 7* draws conclusions from the technical and functional requirements and designs a reference architecture for blockchain-based B2B integration. Finally, I present the WRMHL framework that we use to realize distributed B2B processes.

I hope that the reader, after "mastering" this book, will be somewhat equipped to not only better understand blockchain technology as such, but rather to develop an awareness for possible B2B integration opportunities and their limits. Whoever then in his industry, at his company or in the processes surrounding him comes to the conclusion that the blockchain is not merely a solution without a problem, but rather can affect a fundamental change in his industry not only makes me as the book's author happy, but will moreover be honored with the accolade of the Knightly Order of the Elevator Operators!

If this book thus enables the reader to conceptualize blockchain processes and, in so doing, to perform the required change in perspectives between IT and the business model, then it has fulfilled its purpose. I have intentionally attempted to keep the scope as minimal as possible so that the book can be "digested" on a weekend. At the same time, I hope that the totality of the theme is also reflected by this book without it becoming boring to the crypto-friend in chapters with an energy focus and

without the user prematurely falling asleep when reading the rather technical chapters.

Because a book these days is a very static entity, I have set up a website for the book: http://blockchain-b2b-book.com. Here, I will post information and updates so that the reader can keep up with the latest developments.

In addition, in recent months, we have produced various explanatory videos on various blockchain themes. They can be found on our YouTube channel: to find them, just use the search keys "Ponton", "blockchain" and "channel".

On the English Translation

When reading through the boo, you'll find out that the regional setting of the book is Germany – although I used California as the setting for 75XBOBBY99's story. As the "Energy Transition" kicked in in Germany already several years ago, this is a good place to see, hot the economy, technology, and society adjusts to its reverberation. There are many good and less good stories to be learned from this experience. So I decided not to internationalise the conent of the book but to keep a German focus. Except for rare exeptions, all references to sources in the web and in the literature are in English now. As far as currencies are concerned, Euro and US Dollar deviate by just 10% as this is written, so I did not "Americanize" figures – where Euro or Dollar is appropriate, I just use that curreny. I assume that for the reader, it will be easy to translate. For the writing, I used American English, hoping that my friends from UK will foregive me the many "ization" instead of "isations".

Thanks a lot

Naturally, the effort of writing a book also places demands on the author's personal environment. Thus, I would like to thank my colleagues and employees for their advice which helps to focus the book's content. I would also like to thank Frank Fox for the right to use the microscopic photo of the Volvox algae as the cover photo. Similar to the blockchain, decentrally-organized life emerged from simple, autonomous cells which jointly form the entire organism which also continues to be able to survive even if it loses individual parts. For the English translation, Ron Stelter was a great help in translation and also XXX, YYY, and ZZZ contributed their time to correct and shape the text.

Moreover, I would like to thank the many reviewers and proofreaders who made valuable suggestions as well as ultimately Dilek and Sophie for their understanding and support that I dedicated myself so many weeks to writing this book in extended retreats.

Hamburg, January 3, 2019

1 Foreword

2 Hype or hope?

Why is the theme of "blockchain" only so much hype? The last time that I experienced such an exaltation of a technical theme was at the end of the 1990s – at that time, it concerned the Internet in general and specifically "e-commerce" with all its technical and organizational forms: Pay via the Internet, open a shop online, without the rules and restrictions which would complicate the life of an entrepreneur wanting to open a shop in a small city. That would be something indeed! The late 1990s were full of technological visions which largely anticipated the business models of the Internet today. All the talk was about the "long boom"– economic growth whose end was simply not even in sight, there were a massive number of IPOs (Initial Public Offerings, i.e. young start-up companies initially being listed on the stock exchanges) in the market segments of the stock exchanges which were focused on young technology companies (in Germany, this was the "New Market"). On them, the rules were so weakened that a start-up with a couple of employees, a couple of months of experience, but grand visions could very quickly collect millions of Dollars, DMs or Pounds.

2.1 Blockchain as the dotcom bubble 2.0?

Approximately 30 years were required during this development of the Internet from the specifications of the IP protocol to the dotcom boom at the end of the 1990s while we needed a mere 10 years to go from experiencing the go-live of the first blockchain as it was described in 2008 in the paper from Satoshi Nakamoto [Naka08] to the world today in which ICOs (Initial Coin Offerings) of blockchain start-ups are the content of the daily press, an ever-faster development of new sub-technologies and sub-sub-technologies in which even insiders can quickly lose their overview.

In addition, in the 1990s, there were books like "Blur" [DaMe98] which anticipated the blurring of old boundaries – boundaries between organizations, between divisions, between continents and cultures, between work and leisure-time, because it was already foreseeable at that time that the Internet would eliminate boundaries and that every person could directly contact every other person in the world and that everyone is contactable at any time. At that time, one assumed that there would be a complete decentralization of the society by the Internet. A vision in which only a few Companies like Facebook, Apple, Amazon, Netflix, or Google would centralize a large portion of the data traffic to themselves was inconceivable at that time. Instead, as is the case today, there were people who were excited about the technical visions of decentralization and wanted to participate in this future with lots of expectations.

2 Hype or hope?

At that time, there were still no "meet-ups" regarding the many tech themes which are even much more differentiated today, but, for example, "First Tuesday" events in which the founder, nerd and investor scenes met together to which everybody somehow belonged. And there actually were upheavals in business and society: Today, Agfa and Kodak are part of the past[1]. Children ask today why there is always a cord on the telephone in the old movies and why this telephone has a rotary dial and no display. For many people, the term "rotary dial" has even disappeared from the passive vocabulary. In the technical environment, everything likewise revolved around "e-commerce" which became the hyped theme beginning in the mid-1990s. *XML* (eXtensible Markup Language), for example, was understood to be and marketed as e-commerce technology. It was actually an "enabler" that had made it possible for companies to exchange data in a structured and standardized manner. But XML was greatly overstated: I myself had the privilege to explain during a roundtable of journalists brought together from throughout Europe in 2000 at the Fuschl Castle in the Salzburg region why XML and the organizing company which had discovered XML for itself as e-commerce technology and a marketing message would fundamentally swirl around the world of business for the next 100 years. Well, my presentation was composed of such sober technological terms such as "distributed systems", "B2B integration" and "type-safe validation of XML schemes". Thus, most audience members appeared to be bored and headed over to the buffet with growling stomachs…

"Blockchain – whatever it takes…"

However, the parallels to today are clear: Once again, there is the circle of technological enthusiasts who jump at the chance to acquire a new technology which is not yet completely understood. Once again, we live in a time in which we expect that the only effect of the new technology must be to disrupt all industries for the coming 30 years or more – this time indeed through the blockchain. Once again, in the future, everything will blur into a blockchain stew – from the smart meter to private persons, RFID chips, devices and the few still-remaining companies who have not been abandoned by smart contracts… Best of all, if one still adds also takes "artificial intelligence", the "Internet of things" and "big data" to the stew, then one can do nothing wrong at all – some of these things will somehow fit together well.

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[1] For Kodak, this is now once again no longer completely the case: The company that people believed no longer even existed promoted itself at the end of 2017 with the introduction of its own blockchain by means of which the rights management can be implemented for the intellectual property rights for photos. After this announcement was made, Kodak's share price shot up by 120 %.

In this regard, it is very difficult for non-technologists to assess where the dividing line runs between truth and vision. And if one feels more dutifully obligated to reality rather than marketing, then it is even more irritating to read what is in the press daily regarding the theme of "blockchain".

The decision to transform the theme of "blockchain" from a personal interest to the focus of my professional work was consequently driven by a press release which made the rounds in March 2016: "The First Energy Trading Transaction via the Blockchain Took Place in the Brooklyn Microgrid"[2]. Not that I would have something against energy trading transactions via the blockchain – only if one could have also replaced "blockchain" in such a notification with "MySQL", "Java", "COBOL" or "carrier pigeons". One could have realized the sale of a kilowatt hour (kWh) in *some* manner. But with "blockchain", one has the marketing on one's side – and ten thousand blockchain fans worldwide who celebrate in a knee-jerk manner during each announcement of the following type: "Now Also XYZ using Blockchain". In this regard, the technical characteristics of the blockchain move completely into the background. "Blockchain" has frequently degenerated into a mere transmission belt which one can use in order to obtain worldwide visibility.

In 2017 I gave an interview to a German journalist who even travelled to New York in order to view the "Brooklyn Microgrid" on-site. But there was nothing to find! No "start-uppy" office with a colorful game area, no population which was dancing the blockchain samba enthusiastically on the streets, not even someone who could provide information. Why then? The blockchain takes place in the abstract room, not in Brooklyn. And the handful of solar panels is out of sight on the roofs – five floors above the streets of Brooklyn.

But the Brooklyn Microgrid was indeed the "big bang" for a wave of projects in the "blockchain and energy" segment and thus also gave me the opportunity to also implement the theme of "blockchain" at my own company – however, we wanted to concentrate on the actual potential of the technology in the B2B segment and, in so doing, analyze where precisely the possibilities and limitations lie. We wanted to also find out how one can determine whether a process is a "business case" or not or whether a market is blockchain-savvy or not.

eCash – The mother of all cryptocurrencies

Fortunately, there were predevelopments which were helpful to us in order to quickly familiarize ourselves with this theme. Firstly, I had initially already dealt in the 1990s

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[2] https://www.newscientist.com/article/2079334-blockchain-based-microgrid-gives-power-to-consumers-in-new-york

with the cryptocurrency "eCash" [Chau82] (see above: Everything was already there once…) and then since 2011 with Bitcoin. Moreover, since 2001, my company had already focused on B2B integration – thus, on supporting inter-company processes via the Internet – which indicated a good initial situation.

During the course of my PhD work in the 1990s, the focus was on "Electronic Service Markets" [Merz99], thus simply expressed as "e-commerce" – and which also had, among other things, to do with "payment". Even back then, payment in and of itself also already meant to use a payment process which prescribed the transmission of credit card data via the Internet. There were already hundreds of such processes as there are today thousands of cryptocurrencies. However, payment processes were in principle a rather boring theme that was hardly befitting as a dissertation theme. Conversely, eCash was of a completely different quality. eCash was a *currency* whereby a buyer could pay via electronic coins – and this was also still anonymous, i.e., based on untraceable transactions. In 1996, eCash had captivated more than 30,000 participants worldwide who, during a field test, installed a wallet and who received an initial budget of 100 cyberbucks. There was no possibility of trading between fiat currencies such as the Dollar or the DM on the one hand and cyberbucks on the other hand. The eCash economy was fully disconnected from the world of fiat currencies and had to develop a self-dynamic as cyberbucks had to obtain their own value in another manner. In this regard, there were initial attempts to playfully offer something valuable for eCash. Some people had painted simple digital paintings and sold them for eCash while others had written a poem and again others had begged online for eCash – or simply not rendered a promised service and pocketed the payment.

At the University of Hamburg, we have back then developed a stock exchange game which used the 30 values of the German DAX index once a day and scaled them down by the factor of 100. Thus, if the share price of Volkswagen stood at 50 DM, one could buy a share for 0.50 cyberbucks. Because indeed participants initially had to buy shares from our server before they could later sell them again, the hot wallet of our "exchange" amassed a rather significant cyberbuck amount. During peak times, more than 2,500 shareholders participated in our stock exchange game. The excitement of creating a completely new, independent currency and then trying it out was great at that time. But great was also the level of disappointment that the game would once again be over sometime. eCash was too centralized (a so-called mint server acted as the "central bank" which was simultaneously also a *single-point-of-control* and thus a *single-point-of-failure*). Moreover, the cryptographic overhead was rather high for the hardware capabilities more than 25 years ago. When ultimately Deutsche Bank wanted to bring eCash into circulation, then the German central bank pushed forth a barrier to ban the crypto-hussle because the monopoly on money envisioned only

one issuer – the central bank. And, due to the centralization of eCash, one "operator" was always reachable and liable.

From Bitcoin to blockchain

During the continued course of the late 1990s, the eCash field test then became insignificant, the constantly-swelling new economy bubble demanded a 12-hour day and the later founding of our company as well. From then on, B2B themes were our focus: Supply chain integration in the paper industry during the course of the "papiNet" Project, later-on the data integration between energy traders who confirmed their trade data to each other via XML messaging, the regulatory reporting of energy trading transactions between participants on the energy market and the data repositories of the regulators. And finally, a communication infrastructure which masters the data exchange f the supplier switching process between grid operators and suppliers of power or gas. In any case, this always concerned *standardization* and the related increase in efficiency which resulted in cost reduction and risk minimization.

At the same time, it occurred in 2011 that I – alarmed by the shock waves from the financial crisis as well as due to my private interest – participated in a conference on the theme of "Good Money". There, I became excited about a presentation regarding the private currency "Mark Banco"[3] with the indication that possibly in the distant future that this could also be feasible via the Internet in electronic form. I sent an SMS to a friend in Holland regarding the theme of "private currencies" and received the following answer: "Are you already familiar with Bitcoin?" The rest is personal history for me. I purchased for myself 50 Bitcoins for 2 Euro per unit (which I had already spent again by 2013 – so please abstain from any thoughts on hijacking). Howwever, since then have tracked the development of the first actually successful cryptocurrency – less as an "activist" or protagonist, and also not as a software developer. I rather watched the development since then from the sidelines. Somewhat later, it was realized that Bitcoin actually consists of two halves. The "upper" one is the application "cryptocurrency", the lower one is "blockchain". But, with Bitcoin, the latter was firmly coupled to the former and thus greatly restricted in its broader usage. Freed from this restriction, however, the blockchain technology was already promising much, much more potential in 2012 than "only" supporting cryptocurrencies. Mike Hearn, one of the first developers, who still cooperated with Satoshi

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[3] The Mark Banco was a private currency issued since 1619 by the Hamburger Bank which was backed by precious metal. It was created as the result of an initiative by the Hamburg merchants in order to augment the circulation of counterfeit coins from other currencies with a top-class private currency. In contrast to many fiat currencies, the Mark Banco didn't end in inflation or in government bankruptcy, but rather was replaced in 1875 by the German Reichsmark.

2 Hype or hope?

Nakamoto, was already not tired in 2012 to make reference to the possibilities of using smart contracts on top of Bitcoin – this function was indeed his personal "baby".

However, it still took several more years in which the theme of "blockchain" developed so much of its own self-dynamic that it was soon also recognized by a broader public as an "enabler" specifically for B2B processes. Thus, this coincided with a repeat of the later 1990s: Marketing, hype, misunderstandings and excessively high expectations. Many in the industry were already speaking about trading via the blockchain and for me and also for my company, it was at some point recognizable that, with regards to the blockchain, our business of B2B integration would be affected by the technology and its new methods and possibilities, but also restrictions. It now required only still a small impetus in order to merge both "blockchain" and "B2B integration" and this impetus was then the Brooklyn Microgrid in March 2016.

I then had a few creative sessions with our developers in which we pondered what could then actually be an application case which would be current, as disruptive as possible and suitable for us. The autonomy of the market participants should be promoted, the transaction throughput should remain manageable, i.e. we wanted to not encumber the still-new technology with thousands of transactions per second and we also wanted to demonstrate the disruption potential of the blockchain. From this, both the Enerchain Project[4] (see also Chapter 6.1) and the book chapter "Usage Potential of the Blockchain in Energy Trading" [Merz16] were created.

However, as with all euphoria, one should remain dispassionate. It is always a concern to me to point out that I fundamentally take a blockchain-agnostic viewpoint. On the one hand, this technology also fascinates me and I likewise believe in its potential. On the other hand, my perspective is in no way the perspective of the start-up's founder who wants to blockchain the world with his technology. Based upon my experience as a software developer and entrepreneur, I would always search for the best-possible solution for an application problem. This *can* be blockchain – but doesn't have to be. It *can* be Ethereum, Tendermint, Hyperledger or IOTA. Or a technology which may still need to be developed. As a decision-maker, one should absolutely always remain relaxed here. As one can read in Chapter 5, one can assume that only a small portion of the business processes, which run daily at a company and around this theme, are even blockchain candidates at all. But some of them possess substantial disruption potential – and precisely this makes this technology so exciting.

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[4] http://www.enerchain.com

2.2   The ten greatest blockchain myths

One purpose of this book is to demystify the theme of "blockchain". I would be pleased if people, who have picked up some knowledge fragments here and there regarding the theme, would at least no longer in the future be led astray by the following ten misconceptions. This book will already have fulfilled its purpose if you, as the reader, know why the following statements are misunderstood or false. The terms used below are naturally also explained in detail later in the book.

Misconception No. 1: "The blockchain is slow"

This is correct, but applies above all for Bitcoin – and there even from two perspectives: The block time is on average approximately 10 minutes and, as a rule, one should wait an hour until one's own transaction is securely stored in the blockchain. Such delays occur only with public blockchains. Why this statement is nonetheless false for consortium blockchains will be discussed later in Chapter 3.

In addition, Bitcoin is also slow because only up to seven transactions per second can be processed. This is a weak number which could be improved through a flexibilization of the block size if the developer community only wanted this. Once again, this limitation applies particularly to Bitcoin as a public blockchain – but indeed not for the blockchain principle in general, see also Chapter 3 in this regard.

Misconception No. 2: "The blockchain consumes too much energy"

Here as well, one is referring – without perhaps even knowing it – to public blockchains such as Bitcoin or Ethereum, whose consensus mechanism is based on the "Proof of Work" (PoW) principle. Particularly for Bitcoin, the worldwide energy consumption corresponds approximately to the generation capacity of two nuclear power plants (1-2 gigawatts) which are permanently required in order to fuel the mining process with electrical power. Conversely, a consortium blockchain can be distributed across only a few nodes which respectively cost only a hosting fee of a few Euros per month. In this regard, see also Chapter 3.3 regarding the special characteristics of consortium blockchains.

Misconception No. 3: "The blockchain is insecure"

Yes, stock exchanges looted, Bitcoins stolen, goods not delivered, trading partners are not identifiable or are located in a country with questionable laws, etc. But here robbery and scamming are taking place *on the application level* or even on the level of web front-ends. So this applies once again for cryptocurrencies like Bitcoin and Ether, but not the technology under the hood. As already stated, cryptocurrencies

are composed of two levels – the technical infrastructure (precisely here is where we find the blockchain) and the application for the transfer of units of value (cryptocurrency). Since the beginning of 2009, the infrastructure has – particularly in the case of Bitcoin – rendered its services without any malfunctions or downtimes. This is a quite noteworthy characteristic because normally one can count on an availability of de facto 100 % only with extremely costly technical solutions (clustered databases with hot-standby systems). Combining high availability with low operaton cost is a characteristic which makes blockchain interesting as the infrastructure for distributed processes.

Misconception No. 4: "The blockchain is secure"

The belief has been making the rounds that the blockchain is "more secure" than all previously existing technologies. With "secure", one is referring to the resistance to a wide array of cyber-attacks, thus man-in-the-middle attacks, penetration attempts, DoS attacks, identity theft, etc. Conversely, the category of "safe" includes characteristics such as reliable, robust or available. In the latter discipline, blockchain can definitely "score points".

However, it should also at least offer a level in the area of "security" which can also be found in classical distributed infrastructures – thus typical IT security requirements such as encryption, authentication, integrity and non-repudiation are blockchain-independent and a fundamental requirement on the technical level for each development of distributed software applications. However, not every blockchain technology supports these security mechanisms innately. Thus, it can even be very insecure.

Moreover, it is the case that the blockchain can add a new security level. A classical, centralized system is hopelessly vulnerable to an attacker if this attacker has gotten past the firewall of an organisation's IT infrastructure. Then the attacker can do and leave what he wants to: Delete or manipulate data, infect applications and operating systems with his own code, install bots, etc. However, if an application is now part of a blockchain and this application now decides by way of consensus jointly with others regarding the data truth, then the attacker would have to capture a large portion of the blockchain nodes – and this also even in a short period of time because anomalies can be recognized so that countermeasures can be promptly taken by the others.

The decisive new security feature is the consensus regarding the data truth beyond organizational boundaries and a thus increased robustness against attacks on individual nodes of the blockchain (see also Chapter 3.1 and/or 3.3). That means, for

example, that it would be substantially more difficult for an attacker to simultaneously penetrate Lufthansa, British Airways, Delta, Iberia, Emirates and Air France in order to thus bring down a blockchain which can survive an attack on one third of its members. Exclusively *in this sense* data in the blockchain are actually more secure – a stong asset from a system security perspective!

Misconception No. 5: "Data protection through the blockchain"

Astonishingly, one frequently reads that data in the blockchain is secure – and this is at the same time good for data protection. As previously stated, I have discussed above in detail what "secure" can mean. It must be very clearly emphasized that data in the blockchain are fundamentally *transparent* – thus unprotected! That means they are accessible to everyone who can access the blockchain. "Fundamentally" means that this can be weakened through encryption or hashing mechanisms at a higher application layer. However, one then frequently enters even choppier waters, so to speak, which affects the utilization of the blockchain technology because with encrypted data a validating node can't do very much.

In addition, the data protection legislation prescribes – at least with the GDPR in the EU-Europe – that a private person has a right to the deletion of data if they are no longer required for the original purpose of the storage. Naturally, this violates the great good of the "immutability" of a blockchain. If one would like to once again delete data from historic blocks, does this then still justify a blockchain? Is then the "blockchain" principle even reconcilable with the data protection laws? Reconciling the blockchain and data protection is obviously a difficult undertaking, see in this regard also Chapter 3.4.

Misconception No. 6: "Blockchain is a Database"

Under "database", one would today generally understand a system which very efficiently makes data retrievable in a content-addressed manner via a query interface using indexes and which preserves data consistency. Practically, this is done particularly through a relational data model whereby access is possible through SQL or similar query languages. A blockchain precisely does not provide all this! At least not in in most cases. It is not the main task of a blockchain to *efficiently* manage data. Rather, the blockchain is an electronic file of huge size which can grow in the terabyte range and beyond. Even worse, such a file can only be scanned in a linear manner.

If databases come into play in conjunction with "blockchain", then oftentimes this is as a secondary storage or as a cache in order to enable applications to indirectly access the blockchain's content.

Practically, this means that a blockchain project frequently entails a separate database project. Participants then wonder that this originally lean and efficient technology in its application is suddenly precisely as complex as a classical application development project. The remaining purpose of the blockchain is then frequently only still to carry the "golden copy" of information which is accessed rather rarely, e.g. for documentation purposes or in order to synchronize a higher-level cache database with the "truth".

Misconception No. 7: "The energy consumption of mining defines the value of Bitcoin"

An interesting statement: "With the mining, one consumes a large amount of energy and thus has substantial costs. These costs then define the value of the Bitcoins which a successful miner receives as a reward". Thus, the "Bitcoin" currency ultimately receives an intrinsic value. This is almost a Marxist theory which defines the value of the economic output based upon the work performed.

However, this is indeed false. A cryptocurrency and the mining of its value units are two separate markets which however are closely coupled. Bitcoins in and of themselves have a price which, as with any asset, is derived based upon the demand for the currency and the available supply – regardless of the purpose. If I want to, for example, issue a press release via CoinTelegraph, I have to procure Bitcoins for myself in order to pay for them. The economist calls this "transaction cash". If I am of the belief that the price of Bitcoin will climb to 100,000 Euro, then I procure Bitcoins for myself for speculative reasons. It always requires a community which assigns the "cryptocurrency" asset a value. Otherwise, conversely, the mining for an altcoin currency "DiffiCoin" could be designed as particularly costly so that, via the greatest possible amount of mining expenditures the greatest possible value can be created for that currency.

Conversely, the following is the case: Mining is a business. A miner monitors each day

- how much does the electricity costs,
- how high-performing is his hardware,
- how much reward can he currently expect for the mining activity,
- Up to which which amount can he expect to receive transaction fees,
- and how is the Bitcoin price in relation to his costs, denominated in a fiat currency.

If this calculation works out for him and he promises himself a high probability of success whereby the mining will earn him more than it will cost him, then he will

mine – otherwise not. One can track this based upon the worldwide hash power which increases or contracts with the price development of a cryptocurrency. On the Internet, statistics are maintained which, upon the basis of Bitcoin prices, display electricity costs, technological progress and the price of mining hardware, etc., in order to determine whether it is worthwhile currently to invest in mining. More detailed information in this regard can be found in Chapter 3.

Misconception No. 8: "The blockchain is a decentralized process"

This is true in the sense of the physical distribution of blockchain nodes and also in the sense of the replicated data storage, but the consensus as an important process during the operation of a blockchain has centralized elements as precisely one node is required for the formation of a new block. This leads to grave scaling disadvantages which blockchain enthusiasts are not so readily willing to admit. However, the problem is blockchain-inherent as it is expected that the blockchain maintains a consistent global state of its data content.

For some time, developers have been attempting to create hierarchies for public blockchains (see e.g. "Polkadot" or "COSMOS" in Chapter 3.4), to reduce the consensus to fewer nodes (see "Proof of Authority" in Chapter 3.4) or to federate the data content of the blockchain across nodes through "sharding". However, in this regard, only the scalability limit will be relaxed while at the same time facing a far higher level of complexity.

For a technology which maintains a logically centralized ledger, the term of "distributed ledger" is rather confusing: The ledger is not distributed in the sense that it distributes sections thereof. Conversely, it is maintained as precisely a logically-centralized ledger by distributed nodes.

If thus the provider of a blockchain contends that his system can both scale across millions of participants and can process ten thousand transactions per second and also do this publicly, then all alarm lights should be flashing brightly for a foreseeable period of time.

On the other hand, there are interesting developments which are indeed still rather untried, but promise to master mass transactions publicly with a high throughput. IOTA and Hashgraph are examples of this. Unfortunately, IOTA prescribes no blocks and also no "chain". But hey! As long as the characteristics and goals of such a "blockchain" remain the same, we will still gladly include these species as part of the blockchain zoo. See Chapter 3.3.

2 **Hype or hope?**

Misconception No. 9: "Blockchain X processes 100,000 transactions per second"

Super! A blockchain which can process 25,000 transactions per second! And then the marketing guy comes with another technology with 100,000 transactions per second and, during the podium discussion, tech providers try to outdo each other again and again with new technologies with ever-higher figures. Recently, an Ethereum fundamentalist literally contended: "Ethereum is the fastest blockchain". No. It isn't. In any case not with the 10-20 transactions per second which it currently manages to do. When this was refuted, then the correction came: "Ethereum will be the fastest blockchain in the future". Okay, we will at least have the privilege of witnessing this…

But let's assume that a blockchain can indeed manage to process 10,000 transactions per second. Is this merely a one-time occurrence or can this be done permanently? How many nodes will be involved? And how close will they be to one another? Will there possibly only be one or two nodes directly on the physical cores of the same processor? And how much effort does the validation of a transaction incur? Nobody can or wants to explain this with greater precision. And let's just assume that there were 10,000 transactions times 31,536 million seconds per year times 100 bytes per transaction, then this would be a magnificent 31,536 terabytes. A figure which would have to be taken seriously –particularly if nothing of this figure may be deleted (think of the immutability feature of a blockchain) and the entire history would have to be re-validated once again if a node was added. One should keep the following in mind: With a 200 GB blockchain size today, this already takes days in the case of Bitcoin.

I personally am of the belief that a blockchain technology which successfully processes 50 transactions per second *at the application level* reliably and over the long-term suffices for the majority of all B2B integration projects – also with regards to the risk of being quoted as being the second-biggest flawed assessor in computer history[5]. Presumably, there are only several hundred processes worldwide in which more than 50 transactions per second must be processed.

Misconception No. 10: "We can quicly solve this with a smart contract"

The only thing that is smart in a "smart contract" is the marketing success of the term itself. "Smart contract" suggests that it mainly represents a contractual

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[5] The biggest flawed assessor was Thomas Watson, IBM's CEO in 1943, who forecasted at that time: "I think that there will be a global market for perhaps five computers".

agreement. However, there is nowadays sufficient legal literature which corrects the program logic which resides on a blockchain as "chain code"[6] and not as a "contract".

But even the smart contract as an abstraction for the synchronization of a deterministic, distributed data status is actually no universal means for many distributed software applications as we will determine in Chapter 3.2. Ultimately only ICOs function technically well. But their posssibilities once again justify all restrictions because ICOs and generally "crypto-financing" are presumably *the* innovation of the decade. And precisely for this purpose, smart contracts were originally developed.

However, the misconception persists that each programming task can also be solved with a smart contract beyond the world of crypto-financing. We will nonetheless see that the technology is too slow for this, too limited, too expensive and too "incommunicado". This is essentially the reason why 90 % of all B2B blockchain prototypes initially begin with a smart contract which can be programmed in five days. Then the phase of adaptation to real B2B requirements follows which may often and unexpectedly last many months – in any case much longer than expected! At the end, then many smart contrat based projects experience a reality check and pivot to a solution which uses the blockchain directly as a data channel and less as a distributed execution environment.

Thus, B2B projects become more and more costly the more they approach reality. This statement is naturally trivial because it applies to all projects and technologies. However, with blockchain projects, the reality shock must also be overcome which frequently results in a questioning of the technology being used in the prototype phase. This has the effect that the costs of 20,000 Euro for the smart contract then increase to hundreds of thousands of Euro for a minimally-viable product.

Hopefully, these misconceptions have awakened your interest in now addressing the "blockchain" theme more precisely? From the misconceptions already discussed in detail, it is evident that there is still a big clarification need with regards to the blockchain technology. Similarly to XML in 2000, we still find ourselves in a phase of familiarization and experimentation. Crypto-experts, tech-nerds, application developers, young savages of the developer scene, business visionaries, devotees of the Austrian School of Economics, freedom lovers, marketing specialists, journalists, start-up founders, business developers, decision-makers, investors, innovators as well as persons searching for jobs and fulfilment romp about in the blockchain marketplace.

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[6] This term was very appropriately selected by IBM in conjunction with its "HyperLedger Fabric" product, see also Chapter 3.3.

2 Hype or hope?