Michael Merz

Blockchain for B2B Integration

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Technologies, Applications and Projects

Michael Merz

Imprint

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Table of Contents

Prologue

75XBOBBYFCELL wanted to take a shortcut on the way to Heide, but instead ended up in a massive traffic jam of other robocars in front of him. He hadn't expected so many robocars to end up on this stretch of road this morning. This could really mess up the timing for his filling slot.

Somewhat unexpectedly, 75XBOBBYFCELL had had to take his owner to the dentist that morning. The appointment was at 9:00 a.m. so that he would have to choose another route to Heide for a later time. In fact, on the spur of the moment he also needed to reserve a new filling slot for ten liters because of the appointment at the dentist. Fortunately, he had been able to offload his original slot at 7:50 to 75XXXJULIAD, on the intraday market.

Despite the distance from Hamburg, Heide was still the best location for filling up because the price there for hydrogen was expected to be almost zero for the rest of the day. It had been stormy all night, so as a last resort, even the lead batteries had been charged to the brim. All the available electrolyzers were already running at maximum strength as strong gale force winds had been forecast from the Northwest throughout the morning, lasting at least until midday.

Unfortunately, this long line of cars from Flensburg was about to spoil all his plans. Excessive demand was like poison for prices and 75XBOBBYFCELL could also end up missing his new charging slot! For the last few days, he'd used a new charging station at a wind farm, which was located very near to Heide. Missing his slot would have a very negative effect on his user rating, which he'd been hoping to improve for a long time now.

The smart contract which owned 75XBOBBYFCELL had already worked out very well financially as an investment. Currently, there were 476 holders participating. Although the exact ownership would often change – someone would sell, or someone else would come on-board – but overall, the number of holders remained very stable. 75XBOBBYFCELL's market value was approximately 2,365 Enercoins – not exceptional for a robocar, since the STO had taken place seven months previously, but still pretty satisfactory…

75XBOBBYFCELL's primary objective was to provide the holders with a reasonable yield. This included decisions like the one taken this morning, which was to trade slots at short notice and, in so doing, earn the greatest possible amount of Enercoins. This would include driving somewhat further in order to fill the tank up there, as directly charging at the wind farms in the country offered the biggest cost advantage: no grid usage fee, no surcharges, no levies, no transportation cost for electricity or hydrogen – only VAT chargeable on a minimal amount. In fact, precisely for this reason 75XBOBBYFCELL had recently had the tank capacity extended to twelve liters, which meant it was now good for a range of more than a thousand kilometers.

Several years earlier, at the time of the energy transition, electricity production from the wind farms would often have to be throttled back when they were generating too much power. This went somewhat euphemistically under the name of "feed-in management", although a much better description for this would have been "capital destruction".

At that time excess electricity couldn't be off-loaded through the grid network because the architecture didn't allow for decentralized electricity production. It had long been debated whether, or how, grid capacity might be expanded. However, this would have cost countless millions of Enercoins which, being at the time when fiat currencies were still in use, represented an investment cost of at least 50 billion Euros, if not more. But why not instead just bring the electrolyzers to the generators and thus mitigate power grid congestions wherever they occurred? Hence, each change in the weather forecast immediately resulted in a change in the volume of road traffic. It was so precise you could set the proverbial Swiss watch by it: As soon as an updated forecast indicated wind speed of over 15 knots, within ten minutes the autobahns would be clogged up with hydrogen cars leaving the main cities.

The few humans who still preferred to drive themselves, had long become accustomed to seeing empty robocars stuck in traffic jams all around them whenever they ventured out into the countryside, like an enormous tsunami of giant size boxes on wheels. There had even once been an idea to put life-size plastic dolls in the driver's seat, so that people wouldn't feel that they

had been abandoned on the roads, but this was dropped a few years later, when robocars were no longer being built with drivers' seats.

While he was still deep in thought at these happy memories, 75XBOB-BYFCELL reached Heide to fill up at a gas pump for a few minutes. The hydrogen would last at least for the rest of the week. So, he would still be able to make a couple of trips for hire during the course of the day, and then drive over to pick up his owner once again from the office, at the end of the day.

1 Foreword

Blockchain! One almost doesn't want to hear this term anymore because everybody seems to be 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, leading to a constantly-increasing superelevation of the technology.

Blockchain was propagated as the problem-solver for simply everything – ideally with an admixture of artificial intelligence and big data. Because this notion had continued to intensify, I made the attempt to describe the "blockchain" phenomenon from a rather neutral, agnostic perspective in order to show the possibilities and the limitations of the technology, based on practical experience. Ultimately, this book is the result.

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

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 *B2B* processes from an industry's perspective in order to concretely show which possible applications exist and which details must be kept in mind. In this case, the energy sector serves merely as a placeholder for many other industries in which business processes run that encompass a large number of participants. Based on project examples, it is supposed to ultimately show which processes can be supported particularly well by the blockchain and why.

A comprehensive analysis, starting with the technology and extending to its application level will help the reader to go a step farther and to learn from

these experiences, based on projects with consortia such as Enerchain, NEW 4.0, Gridchain, or ETIBLOGG.

For classification purposes

I wrote this book due of the lack of practical examples known for the niche of "blockchain for B2B integration". Admittedly, it is also a difficult niche since in the "blockchain" segment the difference between desk work, quickly-programmed smart contracts and actual operations is immense. In addition, there is also the fact that actual productive operation has just begun.

The already-existing abundance of blockchain books explains the subject either technically or on the level of "management literature". While doing so, authors have their own perspective on the matter. It is like the good old example of an elephant in a dark room with several people trying to identify it: It appears to be a garden hose, string, tree stump, dagger, leather strap, etc., all at the same time! Book authors also approach the blockchain from various perspectives: There are very good books which address even the program code level of Bitcoin in very detailed fashion. 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 and Ethereum. Whoever would like to obtain an overview can do so with the use of "management literature" á la Tapscott & Tapscott [TaTa16]. Many additional publications illuminate the subject of "blockchain" in detailed fashion from additional perspectives – they emphasize the disruption potential or new possibilities for the company to envision decentralized processes. 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.). While doing so the technical aspect is frequently neglected and one loses the feeling of whether these processes are then truly implementable after taking into consideration the real circumstances. There is a substantial gap between programming a quick 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 reveal themselves during the final sprint.

There is also another perspective on the subject of blockchain –the perspective of a sceptic. At this point, I would like to recommend 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 are a professed blockchain enthusiast as well, please endure David's book and ground yourself! It doesn't benefit anyone to dream of a technology usage whereby important characteristics are neglected and which can then create no added value – in the worst case, the result would only 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 go on an elevator trip as shown in Figure 1 – from the basements of technology to the boardroom and back again. And upwards again and back and this a couple times more. "Blockchain" can be understood best 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.

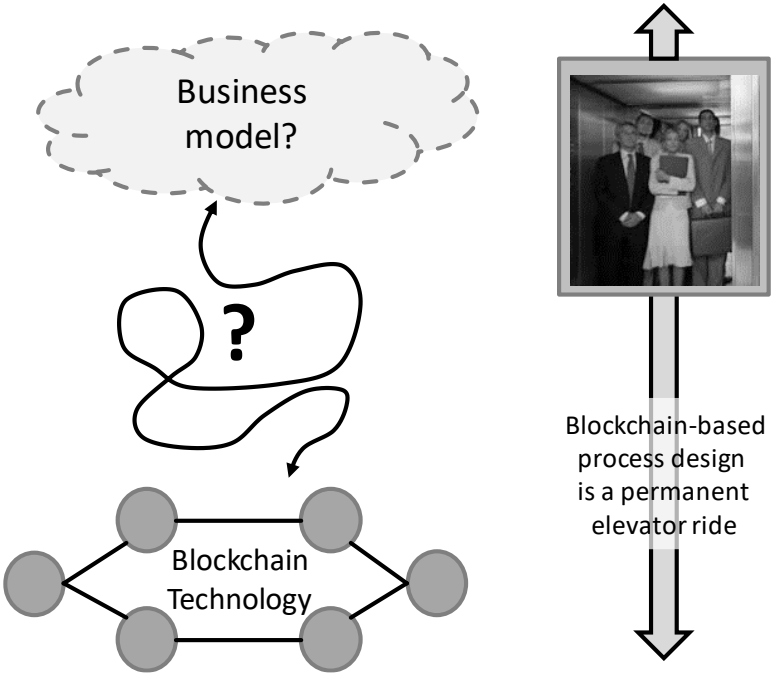

Figure 1: Blockchain projects require a frequent change in perspective

Through this book, I would like to strike a balance while illuminating a few different core themes at the same time. Both the technology, but also the application aspects shall be covered. Since my company PONTON is active particularly in the energy industry, I ask that the reader to bear with me as I have placed the sectorial focus precisely there. This hopefully will also help energy layperson to understand the pros and cons of blockchain within this sector's context and to transfer them to the processes in their own environment.

When writing this book, I have also attempted to analyze other projects, in which we ourselves were not involved, but the problem was in most cases that one could hardly obtain detailed information beyond 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 available in the future, I will naturally include such projects in Chapter 6 in later editions.

The field of "blockchain" has in the meantime become so differentiated that this book will largely not deal with standard questions regarding cryptocurrencies: one could expect in detail the special characteristics of DASH, Zcash, NEO, etc. as well as their history, tools and possibilities to trade them or everything which can befall an investor holding crypto. In this regard, one can find interesting publications such as [Hosp17]. Likewise, issues regarding crypto exchanges, investment in tokens, ICOs, STOs, or advices how to get involved in mining are not in the forefront of this book.

Blockchain for B2B integration

Under a *B2B blockchain*, I understand a business to business (B2B) 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 based on cost-effective, redundant nodes for efficient coordination.

B2B blockchains offer the opportunity to optimize or replace existing business processes. Accordingly, the impact is disruptive on the organization of current commercial interaction. This is less visible in the public eye, as blockchain projects in the industry are frequently conducted behind closed doors – noisy marketing is not required beyond sector boundaries. The goal of such projects lies in process optimization and not in the broad publication of the results.

When considering blockchain, 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 utilizes the blockchain's potential even better?". 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 old

processes patterns?". "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 shall 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 on a regular basis. Sometimes, technology is the starting point for the analysis: "How can we utilize the high availability, trustlessness and lower operational costs to our benefit?" Sometimes, business-level requirements are in the focus: "How can I allow the customers to participate in the process without violating data protection laws?"

With regards to "classical" IT projects, the "business case" marks the starting point. It encompasses one's own company as the driver of a development. A new solution needs to be implemented, a process is required to be more efficient, an application must be developed which is supposed to fulfil new external or internal requirements. From this, a plan and a set of specifications are created which are then implemented following the traditional waterfall model for software development or an iterative approach. 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, the corresponding performance requirements are implemented in such a manner that the highest-possible quality is attained during the operational phase as well. Everything "in time, in budget, in quality" – as always… In each case, however, the solution follows the problem.

And now there is this blockchain technology! Everybody is excited to develop something with it and to try it out in order to see whether the goal can also be reached 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 topic.

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 the waiting period until a consensus is reached. Finally, the question arises regarding where the many nodes are supposed to be installed – and why all of this when actually only the good old club administration software is supposed to be updated?

It would make no sense technically to plug the blockchain simply under the classical application design for the development of a club administration software. For marketing purposes, this perhaps makes sense, but the administrator who is responsible for system operation would probably resign immediately. So, a prototype remains which can however be used to at least still run a blockchain-operated club administration software. Through such innovations, the market capitalization of a company may even increase…

However, at this point it is getting obvious that **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 a new business model by keeping in mind 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 organization will only be a "cog in the wheel" of the overarching future process. In this respect, it is better for a person to think like an economist rather than a business manager in order to discover the global benefits of the technology.

This once again requires even more the close co-operation between technical blockchain experts and business innovators who listen to one another and jointly "explore new territory". Such an approach is always useful and frequently demanded by innovation managers. Countless terms and seminars exist for this, but, nevertheless, this is no cakewalk. Following Figure 1, 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 operational business processes, and finally to the executive management floor of the cross-industry transformation of processes and markets. Accordingly, many experts must be synchronized because individual persons who can simultaneously master all knowledge fields are indeed rare.

Content overview

In this book, such an elevator trip is supposed to be made 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 several blockchain technologies is explained – sometimes based on Bitcoin because it is the mother of all blockchains, the best-understood and the best-documented, but sometimes also on the basis of technologies which are more relevant for industry consortia.
- The focus of this book lies on B2B integration based on consortium blockchains. In this regard, it illustrates some applications which industry consortia are implementing today. In order to understand these use cases better 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 in the long term as a result of the energy transition.
- After the elevator trip between the technological solution and the energy transition requirements, it will be examined in *Chapter 5* how intercompany processes can be supported by the blockchain and what requirements this poses for the consortia governance.
- *Chapter 6* presents typical blockchain use cases from research and practical application with an energy transition background and which lead to the vision of "Scenario 2030" in Chapter 4.
- *Chapter 7* draws conclusions from the technical and functional requirements and leads to a reference architecture for blockchain-based B2B integration. Finally, I present the WRMHL framework that we use to realize decentralized B2B processes.

I hope that the readers, 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 their industry, at their company or in the processes surrounding them comes to the conclusion that the blockchain is not merely a solution without a problem, but rather can affect a fundamental change in their 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 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 "enjoyed" on a weekend. At the same time, I hope that the totality of the matter is also reflected by this book without it becoming too boring to the crypto-friend in chapters with an energy focus and without the business manager prematurely falling asleep when reading the rather technical chapters.

Because a book is a very static entity these days, I have set up a website to continue the content through a blog: 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, we have produced various explanatory videos on various blockchain themes in recent months. They can be found on our YouTube channel: to find them, just use the search keys "ponton", "blockchain" and "merz" and go to the English playlist.

On the English translation

When reading through the book, you'll quickly find out that its regional setting is Germany. As the Energiewende ("energy transition") kicked in in Germany several years ago, this is a good place to see, how 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 internationalize or "europeanize" the content of the book but to keep a German focus.

Except for rare exceptions, all references to sources in the web and in the literature are in English. 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 the currency that fits best the context. I assume that for the reader it will remain easy to translate into familiar figures. For the writing, I used American English, hoping that my friends from UK will forgive me the many "…izations" instead of "…isations". Finally, I hope that several re-works of the text helped to eliminate most of the Germany syntax artefacts and that my English doesn't sound too much like Yoda's…

Thanks a lot

Naturally, the effort of writing a book also places demands on the author's personal environment. I would like to thank my team at PONTON for their advice which has helped in sharpening the book's focus. 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 survive even if it loses individual parts. A first raw translation was made by Ron Stelter, but without the input from so many more experts, it could not have been fully accomplished by myself: Specifically, Bhanu, Wolf, Jason, Gavin, Jonathan, and Anthony contributed their time to improve the English translation of 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, November, 2019

2 Hype or hope?

Why is the subject of "blockchain" such a hype? The last time that I experienced a similar exaltation of a technical matter 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 city center. 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[1] in the market segments of the stock exchanges which were focused on young technology companies. Here, 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 for this development of the Internet from the specifications of the IP protocol to the dotcom boom at the end of the 1990s while it only took us 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 and STOs (Initial Coin Offerings / Security Token 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 – 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

[1] Initial Public Offerings, i.e. young start-up companies initially being listed on the stock exchanges. in Germany, this was the Neuer Markt ("new market").

eliminate boundaries and that every person could directly contact every other person in the world and that everyone is reachable at any time. Back then, 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 their platforms 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.

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 and to which everybody somehow belonged. And there actually were upheavals in business and society: Today, Agfa and Kodak are part of the past[2]. 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 all over Europe in the year 2000 at the Fuschl Castle in the Salzburg region why XML and the organizing company which had discovered XML for itself as an e-commerce technology and as a marketing message would fundamentally swirl the world of business for the next 100 years. Well, my presentation was composed of such sober technological terms as "distributed systems", "B2B integration" and "type-safe validation of XML schemas".

[2] 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 %.

Consequentially, the audience 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 grasp the chance to adapt to 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 blockchain. Once again, in the future, everything will blur into a blockchain stew – from the smart meter to individuals, RFID chips, devices and the few still-remaining human-led companies who have not been abandoned by smart contracts… Best of all, if one also adds "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.

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 daily press regarding 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"[3]. With "blockchain", one has the marketing on one's side – and ten thousand of blockchain fans worldwide who celebrate in a knee-jerking manner during each announcement of the type: "Company XYZ has announced using Blockchain". The technical characteristics of the blockchain are completely shoved 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

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

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 exists in the abstract space, not in Brooklyn. And the handful of solar panels are out of sight on the rooftops – 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 implement the subject of "blockchain" at my own company – however, we wanted to concentrate on the actual potential of the technology in the B2B segment and, in doing so, 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 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 – 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], simply expressed as "e-commerce" – and which also had, among other things, to do with "payment". Even back then, payment meant to transmit credit card data via the Internet. There were already hundreds of such processes as there are today thousands of cryptocurrencies. However, payment processes were a commonplace subject 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 using 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 installed a wallet during a field test and who received an initial budget of 100 cyberbucks. There was no possibility of trading

between fiat currencies such as the Dollar or the Deutsche Mark (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 artworks 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, back then we developed a trading game which downloaded the 30 values of the German DAX index once a day and scaled them down by the factor of 100. I.e., if the share price of Volkswagen stood at 50 DM, one could buy a share for 0.50 cyberbucks. Since participants did indeed have to buy shares from our server initially before they could sell them again later, we collected a rather significant fortune of cyberbucks in our central exchange wallet. During peak times, more than 2,500 shareholders participated in our game. The excitement of creating a completely new, independent currency and then trying it out was great at that time. But there was also great 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 25 years ago. When ultimately Deutsche Bank wanted to bring eCash into circulation, then the German central bank banned the crypto hype because the monopoly on legal tender designates only one issuer – the central bank. And, due to the centralization of eCash, the one "operator" was always reachable and liable.

From Bitcoin to blockchain

Later in the 1990s, the eCash field test became insignificant, the constantly-swelling new economy bubble demanded 12-hour working days and in the year 2001 our company was founded. From then on, B2B integration was 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 based on XML messaging, the regulatory reporting of energy trading transactions between energy

market participants and the data repositories of the regulators. And finally, a communication infrastructure which masters the data exchange for the supplier switching process between grid operators and suppliers of power or gas. In any case, this was always linked to *standardization* and the related increase in efficiency which resulted in cost reduction and risk minimization.

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 subject of "Good Money". There, a presentation regarding the private currency "Mark Banco"[4] excited me which indicated that possibly in the distant future this could also be feasible via the Internet in electronic form. I sent an SMS to a friend in Amsterdam regarding "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 kidnapping!). However, since then I 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 was still cooperating with Satoshi Nakamoto, was not tired in 2012 to refer 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 subject of "blockchain" developed so much of self-dynamic that it was soon also recognized by a broader public as an "enabler" specifically for B2B processes. This

[4] 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 merchants from Hamburg in order to counteract 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.

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 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 a small impulse in order to merge both "blockchain" and "B2B integration" and this was the Brooklyn Microgrid in March 2016.

I then had a few creative sessions with our developers in which we pondered what could actually be an application case which would be current, as disruptive as possible and suitable for our business. 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[5] (see also Chapter 6.1) and the book chapter "Potential of the Blockchain Technology in Energy Trading" [Merz16] emerged.

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 fascinates me and I likewise believe in its potential. On the other hand, my perspective is in no way the perspective of a start-up's founder who wants to "blockchain the world" with their technology. Based upon my experience as a software developer and an entrepreneur, I would always search for the best-possible solution for an application problem. This *may* be blockchain – but doesn't have to be. It *may* 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 inside a company or around it, are even blockchain candidates at all. But some of them possess substantial disruption potential – and precisely this makes this technology so exciting.

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

2.2 The ten greatest blockchain misconceptions

One purpose of this book is to demystify the subject of "blockchain". I would be pleased if people, who have picked up some knowledge fragments here and there, would at least no longer be misled 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 that primarily from two perspectives: The block time is on an average 10 minutes in case of Bitcoin and, as a rule, one should wait an hour until one's own transaction is securely stored in the blockchain, i.e., until finality is reached. 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 capacity generated by two nuclear power plants (1-2 gigawatts). This energy is 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 with reference to 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 quite a noteworthy characteristic because normally one can count on a system availability of de facto 100 % only with extremely costly technical solutions (clustered databases with hot-standby systems). Combining high availability with low cost of operation is a characteristic which makes the blockchain interesting as an 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, man-in-the-middle attacks, penetration attempts, DoS attacks, identity theft, etc. Conversely, the category of "safety" also includes characteristics such as reliable, robust or available. In the latter discipline, blockchain can definitely "score points".

However, the technology should also at least fulfill basic requirements in the area of "security" which can also be found in classical distributed infrastructures – 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. I.e., 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 organization's IT infrastructure. Then attackers can do and leave what they want to: Delete or manipulate

data, infect applications and operating systems with their 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 in a short period of time because anomalies can be recognized so that countermeasures can be promptly taken by the other node operators.

The decisive new security feature is the consensus regarding the data truth beyond organizational boundaries and an increased robustness against attacks on individual nodes of the blockchain (see also Chapters 3.1 and 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 bring down a blockchain which can survive an attack on one third of its members. Exclusively *in this sense* data in the blockchain is actually more secure – a strong 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 in detail what "secure" can mean. It must be very clearly emphasized that data in the blockchain is fundamentally *transparent* – thus unprotected! That means it is 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 rougher waters, so to speak, which affects the utilization of the blockchain technology because the validation logic can't do very much with encrypted data.

In addition, the data protection legislation stipulates – at least with the GDPR in the EU – that a private person has a right to the deletion of data if it is 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 compatible with

privacy 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 through a query interface, using indexes, and preserving 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 most cases. It is not the main task of a blockchain to *efficiently* manage data. Rather, the blockchain is a massive digital log file which can grow up to a terabyte and even 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 as complex as a classical application development project. The remaining purpose of the blockchain is then frequently only 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 mining, one consumes a large amount of energy and has substantial costs. These costs then define the value of the Bitcoins which a successful miner receives as a reward". I.e., 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 even though they are closely coupled. The

price of Bitcoin is derived, as with any asset, based upon the demand for the currency and the available supply – regardless of the purpose. For example, if I want to issue a press release via CoinTelegraph, I have to procure Bitcoins for myself in order to pay for it. 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 a value.

Otherwise the mining for a hypothetic cryptocurrency "DiffiCoin" could be designed as particularly costly so that, via the greatest possible amount of mining expenditures the greatest possible value would be created for that currency. However, such a currency does not exist.

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

- how much does the electricity cost,
- how high-performing is the hardware,
- how much reward can currently be expected for the mining activity,
- which amounts can be expected to be received as a transaction fee,
- and how is the Bitcoin price in relation to the above costs, denominated in a fiat currency.

If this calculation works out for the miner and if 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 decreases with the price development of a cryptocurrency. On the Internet, statistics are maintained which, based on Bitcoin prices, display electricity costs, technological progress and the price of mining hardware, etc., in order to determine whether it is worthwhile to invest in mining now. 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 their 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 subdued 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 years, developers have been attempting to create hierarchies for public blockchains (see e.g. "Polkadot" or "COSMOS" in Chapter 3.4), to reduce the consensus algorithm to fewer nodes (see "Proof of Authority" in Chapter 3.4) or to align 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 a logically-centralized ledger replicated across distributed nodes.

If thus the developer of a blockchain technology contends that the 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, Hashgraph, and Apache Kafka are examples of this. Unfortunately, neither IOTA nor Kafka use 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.

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

Super! A blockchain which can process 25,000 transactions per second! And then another marketing guy comes with another technology with 100,000 transactions per second and, during the panel 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 monstrous file of 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 250 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 – maybe with the risk of being quoted as being the second-biggest flawed assessor in computer history[6]. Presumably, there are only several hundred processes worldwide in which more than 50 transactions per second must be processed.

Misconception No. 10: "We can quickly 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 agreement. However, there is nowadays sufficient literature which

[6] 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".

corrects this notion that it resides on a blockchain as "chaincode"[7] and not as a "contract".

But even the smart contract as an abstraction for the synchronization of deterministic, distributed data status is actually not a universal solution for many distributed software applications as we will determine in Chapter 3.2. Ultimately only ICOs function technically well. But their possibilities 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 contract-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 project then increase to hundreds of thousands of Euro for a minimally-viable product.

Hopefully, these ten 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 need for clarification regarding the blockchain technology. Similarly to XML in the

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

year 2000, we still find ourselves in a phase of familiarization and experimentation. Crypto-experts, tech-nerds, application developers, enthusiastic youth from 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 walk around in the blockchain marketplace.