Intellectual Property Protection Strategies for Blockchain Technology Applications

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We do IP. HOYNG ROKH MONEGIER

Executive Summary

The relationship between intellectual property law and innovation has been disputed by scholars in academic literature for a long time. It is generally accepted that the rigid formalities of intellectual property law result in a bad fit with the flexible and volatile nature of emerging high technology. The conditions under which the connection between intellectual property law and emerging high technology occurs are likely to be twofold. First, the maturity of the technology to be protected and, second, the demand for the valorisation of the technology. These are in turn driven by technology-specific drivers. To solve the high-level problem of a generic gap between emerging high technology and intellectual property law, this research aims to create a decision-making framework that might aid patent attorneys, and by extension, the proprietors of intellectual property rights, in determining how to protect the intellectual property of Blockchain technology applications. Blockchain technology is an excellent starting point for this research, and subsequently the solution to the high-level problem. First of all, the adoption rate of the technology is extremely high, thereby strengthening the effects of any change in the demand for valorisation. Second, the technology is prone to regulatory changes that affect the applications and by extension, the volatility of the technology. Third, the technology is rooted in a context of Open Source development, thereby having a limited initial demand for patentability, which means the regular gradual patentability of the technology is stifled. Finally, the jurisdictions in which protection of the intellectual property is needed provides a problematic situation as there exists a discrepancy between the global nature of the network-based technology and the national law to which the protection must adhere, which is a structural mismatch between the technology and the intellectual property law supposed to protect it.

In this research, the aforementioned decision-making framework will be developed by considering what is the most appropriate intellectual property right and what strategic options exist in this intellectual property right. Then, by analyzing the characteristics of the Blockchain technology and its proprietor, and their effects of the strategic choices, a theoretical decision-making framework can be developed. Further, this theoretical model will be subjected to results of patent analysis and case law analysis to create a validated decision-making framework. In this process, the granting rate of Blockchain-related intellectual property rights, the contents of granted applications and key decisions in both prosecution and litigation are analysed.

The blockchain technology that is to be subjected to intellectual property law will be categorized into three parts, the distributed ledger, which is the consensus mechanism of the technology, the smart contracts that determine the way in which the consensus mechanism is applied, and the technical effect of the application of the technology, by which the conditions of protection are met through the application of the technology to an invention, rather than reinventing the technology.

Considering these layers, the best intellectual property right to protect the intellectual property of Blockchain technology applications are patents, wherein strategic options can be categorized into the filing route, the part of the technology to be protected (i.e., which of the abovementioned layers), and the formulations of the claims that confer the to be protected subject-matter. The filing route can be national, regional, or global, with possibly including a priority right. The part of the technology is dependent on the patent-eligibility of the separate layers. Finally, claim formulation can be split into three parts, the preamble, the transitional phrase, and the body, which all are dependent on certain characteristics of the technology or the proprietor of said technology.

Concerning the filing route, the level of jurisdictional preference due to competition and the costs of this protection will affect the filing route. Furthermore, a patent-analysis shows that the countries most likely to provide patent protection for Blockchain applications at this point in time are South Korea, Australia, the United States of America, and Japan, respectively. Based on a comparison with software patents, it is likely that the granting rates of South Korea and Germany will decline, whereas the granting rates of Taiwan, the United States and China will rise.

The part of the technology to be protected is dependent on the patent-eligibility of the improvement on the state of the art that is achieved through the application or the adaptation of the blockchain technology. The test for the patent-eligibility of each part of the Blockchain technology application is rooted in an assessment of novelty, inventiveness, and industrial applicability. The patent and case analysis of the part of the technology shows that there is no such binary delineation between the consensus mechanism and the technical effect achieved by the application of the technology. The Blockchain technology application should be protected by disclosing only those parts of the technology that are vital for the explanation of the technical effect, regardless of whether that technical effect is achieved by the consensus mechanism or by the application of the technology. A patent must disclose the relevant features to allow a person skilled in the art to execute the invention and a person skilled in the art of cryptography would know what Blockchain to use for the intended invention. Furthermore, based on the case law in the US, there is a need for the disclosure of an inventive concept, not only the disclosure of an abstract idea. The application of a Blockchain system to an existing technical field without specifically indicating what synergies are achieved by said implementation is not sufficient for patent-eligibility. The difference between the patentability of Blockchain technology application in the US and Europe can be attributed to the inclusion of *Alice* and the machine-or-transformation test, in connection to the joint infringement matters as proposed in the *Akamai* cases and *Medg3raph*. With respect to the part of the technology, the subject-matter of an invention must, both in the US and in Europe, disclose a further technical effect than the mere implementation of the technology to an existing process or technical field.

Finally, with respect to the formulation of claims, the preamble is determined by the type of the technology to be protected, the transitional phrase is dependent on the level of specificity of the characteristics and the claim body must confer the subject-matter, which must be patent-eligible by the tests as described in the previous paragraph. The embodiment of an invention, along with the existent prior art will be assessed by a patent attorney, which leads to a claim taking into account the patentability of the claim and the previous formulated claims. Then, the selection of the independent claim in a Blockchain technology patent application is done by identifying the allowable features of the technology through the law, and subsequently by determining the proprietor preferences regarding the protection of the new invention. Based on the case-analysis, the preamble of a Blockchain patent must include a method claim, followed by a system and a storage medium or other type of physical feature. This is in congruence with the US case law, wherein *Alice* and its Machine-or-Transformation test confers that a physical feature is needed in the to be protected subject-matter. Furthermore, in the formulation of claims, joint infringement as explained in *Akamai*, *Medgraph*, and *Lilly* should be circumvented by including only one actor in the independent claim to perform all of the infringing actions. The resulting best practice with consideration of these cases would be to direct claims at individual actors, so as to prevent joint infringement. Should this not be possible, due to requirements of *Alice* and the patent-eligibility trilogy, the claims should be directed actors that are controllable with as little ambiguity as possible. As such, the claim formulation could be squeezed between joint infringement and the Machine-or-Transformation test.

As a result of these conclusions, the implications for industry can be identified. Patent offices are likely to become more adoptive of emerging high technology. From a regulatory perspective, with reference to intellectual property law, the solution for the ill-equipped rigid law to deal with emerging high technologies lies in adopting a degree of flexibility. From the law, this is neigh-impossible, which leads to the consideration of a feedback process that is more effective, thereby allowing legislators to respond as quickly as possible to emerging high technology. Patent offices can make the costs of patent protection dependent on the revenue of the proprietor, to limit unnecessary patent protection without stifling innovation. Further, a case could be made for a change in patent infringement. If unbeneficial use of a patented technology would not constitute an infringing action, the barrier of intellectual property to the development of new technologies would be eliminated. The licensing payments would then be dependent on the profits generated as a result of the use of this technology, stimulating innovation to a higher degree.

Preface

During the course of five months, I had the pleasure of being able to work on this research with the great help of a number of people who contributed, in one way or another, to the completion of my thesis.

After reading this research, it might be imaginable that the leap from Mechanical Engineering and the faculty of Technology, Policy and Management to intellectual property law, cryptography and computer sciences is quite substantial. While for me this was an excellent challenge, finding a supervisory committee that was enthusiastic about research that could not possibly encompass their respective fields completely, was slightly difficult. Fortunately, I found such a supervisory committee in Professor van den Hoven and Dr. Roosenboom-Kwee.

Professor van den Hoven was a great help in the development of this research, through advice and discussions. Having a professor that is interested in your research, friendly, supportive and open to discussions, is rather extraordinary and I thank you for the valuable additions to this research you have provided. In addition to Professor van den Hoven, and thereby completing the supervisory committee of my graduation, Dr. Roosenboom-Kwee allowed me to deliver a thesis of far greater quality that it would have been without her critical guidance, which was much appreciated. The degree of enthusiasm and support from Dr. Roosenboom-Kwee has been extraordinarily helpful for the development of this thesis. Both Dr. Roosenboom-Kwee and Professor van den Hoven allowed the creation of a non-standard thesis and were enthusiastic, rather than hesitant with respect to the unconventional proposal, for which I am very grateful. Furthermore, a thank you goes out to Georgy Ishmaev for his advice and kind words of encouragement.

In addition to the supervisory committee from the Delft University of Technology, various people at HOYNG ROKH MONEGIER allowed me to work on my thesis in their office, using the knowledge made available by them and at least as important, made for a very welcoming place to write my thesis, for which I thank you all. HOYNG ROKH MONEGIER, and all of its employees without exception, have been accommodating and stimulating for the development of this thesis. Also, they have allowed me to learn an incredible amount about intellectual property law by including me into their day-to-day life and by allowing me to work to a vast array of different cases in prosecution and litigation. In the span of 5 months, I have worked with over 20 companies, attended 4 court hearings and organised 5 events. All in hugely different industries, with different people, in different parts of the world. This led me to gain the knowledge needed for this thesis but also to become enthusiastic about the field of intellectual property law.

At HOYNG ROKH MONEGIER, a number of people contributed in particular to the creation of this thesis. Peter Haartsen, who was my direct supervisor within the company, delivered his critical view from a patent attorney perspective, which was extremely helpful. Wilbert Derks, David Owen, Rembrandt Donkersloot, Christopher Pierce, Erik Lumens, Michiel de Baat, Jeroen den Hartog, Frank Eijsvogels, and Robin van Kleeff, I thank you for the pleasant collaboration with the non-thesis-related work. Ronny Amirsehhi a special thank you for putting up with the pesky student in your office.

Finally, a note should go out to my roommates, Ynze Strikwerda and Michiel Steegmans, for their support regardless of my absence. Although the last five months have been characterised in me not being at home, even during weekends, you have provided me with advice and support. And, last but not least, my girlfriend, Melline Schilham, for her support, feedback and patience.

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1 Introduction

"Simplicity is the final achievement. After one has played a vast quantity of notes and more notes, it is simplicity that emerges as the crowning reward of art."

– Frederic Chopin –

The buzz around Blockchain technology has grown over the last decade. Everywhere, people are discussing its potentially disruptive properties and arguing over whether or not to invest in cryptocurrencies. The enthusiasm towards the technology is likely not to have surpassed readers of this document. While concerned with the subject of Blockchain, this research does not aim to make use of the technology, nor to speculate on its ability to change the world. This research aims to address an issue that emerged as a result of the level of attention the technology is getting; the substantial increase in demand for protection of intellectual property rights of the technology (Jalfin, 2017), and the resulting gap between the technology and the law that should protect the intellectual property rights of the inventions that make use of Blockchain technology. This section will provide an introduction to intellectual property law – in particular patents – and Blockchain. Afterwards, the problem statement will be presented, along with the research questions, approach, relevance and thesis structure.

1.1 Intellectual Property Law

Intellectual property law deals with the protection of intellectual property; intangible assets that provide value to a person or a company. A definition is provided by WIPO (World Intellectual Property Organization): *"Intellectual Property (IP) refers to creations of the mind, such as inventions; literary and artistic works; designs; and symbols, names and images used in commerce."* (WIPO, What is Intellectual Property, 2018). IP law allows for the valorisation of knowledge by converting it into property. This property is then protected by intellectual property rights, such as patents, trademarks, copyright, design rights, utility models, trade secrets, semi-conductor topographies, database rights, domain names, trade names, neighbouring rights, breeder rights, geographical indications, portrait rights, and confidentiality. The workings of intellectual property law are complicated, every country in the world has its own system to protect intellectual property and every country has their own interpretation of their system. Understanding how intellectual property law works, completely and fully, especially when taking the country-specific subjectivity into account, takes years. So, the subject will be marginally simplified by providing a broad overview of the most important types of intellectual property rights and zooming in only to those aspects that are useful or interesting. In chapter 2, intellectual property law will be elaborated on in great detail. In chapter 4, the reason for choosing patents as the main point for focus will be explained.

Definitions of intellectual property law and what it entails differs across the globe. To provide a sufficient level of insight for the reader into the topic of intellectual property, the World Intellectual Property Organization (WIPO), the agency specialized in intellectual property of the United Nations, will be leading. Their analysis of intellectual property law and methods of enforcing that law should prove to be sufficiently exhaustive for a preliminary insight into the field, yet superficial enough to circumvent the implications of regulatory differences in various countries. By WIPO, intellectual property is usually divided into two categories, industrial property, which includes patents for inventions, trademarks, industrial designs and geographical indications. And copyright, which covers literary work, films, music, artistic work and architectural design, and the rights related to copyright, such as performing artists in their performances, producers of phonograms in their recordings and broadcasters in their radio and television programs (WIPO, What is Intellectual Property, 2018). The main types of intellectual property rights, copyrights, trademarks, industrial designs, geographical indications and patents will be discussed in chapter 2. These are provided by WIPO as the predominant methods of protecting intellectual property rights, they encapsulate the most important rights, also for this research, and show the working principles of the law.

1.2 Blockchain

A Blockchain is a growing list of records, called a ledger, using public-key cryptography to sign transactions, which is distributed among the participants, called nodes, in a network. Blocks are completed transactions which are added to this distributed ledger over time (also see Glossary). To make this technical description tangible, a simpler explanation can be provided. A ledger is a complete list of transactions in a network of, for instance, a bank. This list is used to verify transactions and to track assets. This list is what provides a bank with the possibility to determine the amount of funds you have. In a Blockchain network, every node has a full list of these transactions and, as a result, every node can verify every transaction. This means users are no longer obliged to trust the bank and its ability to handle this rather complex system. The users can do it themselves now. This valuable characteristic of operability without having to trust a third party is increasingly leading to widespread use of the concept, from its first application in finance to a wide variety of industries (Meola, 2017). For the purpose of the research, the distributed ledger technology and encompassing consensus mechanisms will be discussed. This enables us to incorporate technical improvements to the existing technology without falling outside of the scope of this research. This means, as explained in the glossary that the definition of Blockchain technology includes adaptations to the technology that use a consensus mechanism that deviates from the first notion of Blockchain technology (Nakamoto, 2008). A more in-depth explanation of Blockchain and what it entails will be provided in chapter 2.

The following aspects of Blockchain technology are important to consider with respect to the relationship between emerging technology (in this case Blockchain) and intellectual property law (see figure 2); the adoption rate, the regulatory change, the Open Source culture of the Blockchain community, and the levels of jurisdictional protection in case of infringement of intellectual property rights. The adoption rate affects the connection between law and technology as a new technology that has a high entry-rate in a technical field allows the law little time to adjust to the new technical characteristics. The regulatory change and resulting push for standardization adds to the level of uncertainty regarding the development of the technology. The speed with which a technology is adopted affects the influence of regulatory change on the development of the technology. After all, if a technology is not being adopted at a high rate, a change in regulation would not be a big problem. However, if many people or companies are already developing the technology, a regulatory shift could have far greater effects. The influence of Open Source on the protection of intellectual property rights leads to a consideration of the context of the Blockchain technology and will assess the awareness of intellectual property rights in the world of Blockchain technology development and the willingness to participate in the protection of these rights. As a result, the existence of Open Source software in the production of the inventions that this research discusses, further increases the gap between the law and the technology. The Open Source culture, as will be described below, creates a barrier between the initial stages of development of the technology and intellectual property law. Finally, the level of jurisdictional protection is problematic in case of infringement litigation of any intellectual property right. The intellectual property rights that should protect the technology is aimed very specifically at countries, while the technology itself starts transcending country borders at an increasing rate.

1.2.1 Adoption Rate

Blockchain is a technology that is in existence since the first introduction, as part of Bitcoin, in 2009 (Nakamoto, 2008); (Schatsky & Piscini, 2016). Since the introduction into finance, the application of the technology on industries has spread at a high rate. As mentioned, the introduction of the technology in various industries is driven by the attention cryptocurrencies got over the last years. Discussions on the actual value of the technology are still ongoing (Stinchcombe, 2017). It now ranges from cloud-computing (Golem, 2018) to online gambling (Draksas, 2018) and is often claimed to be a valuable technology for the future. Even if it turns out not to be true, there is an increase in demand for protection of the intellectual property of inventions that make use of this technology, which can be seen in a sharp increase in patent

applications. Apart from banking and finance, Blockchain is emerging in, amongst others, voting, identity systems, social inclusion, and supply chain (Pilkington, 2016). As the use of Blockchain technology is increasing in a vast variety of industries, the demand for protection strategies for the technology is also increasing because incumbent firms are hesitant to invest in lengthy research and development if they have no ability to protect their invention from competition (Varsakelis, 2001). Although this is often driven by the popularity surrounding the topic, the noticeable increase of use cases, as can also be seen in the patent applications, clearly shows the fast growth of the technology (figure 1). The figure below clearly shows the significant increase over the last couple of years, non-cumulatively. It should be noted that the recent decrease in applications is due to the publication data, which is only mandatory after eighteen months in patent law. So, the past eighteen months as depicted in the figure show less applications than are actually there, the non-highlighted area shows the trend containing a full data set. The data in this graph has been gathered by searching patents and patent applications containing the words Blockchain or Distributed Ledger using PatBase, which will be discussed later (section 3.2.1). The figure shows the applications for patent protection in ten jurisdictions, which will also later be discussed more in-depth. This sharp increase in patent applications adds to the problematic connection between emerging high technology and intellectual property law as the speed of adoption limits the ability of the law to adapt to the innovative technology, which results in a time-lag and a period of uncertainty of IP.

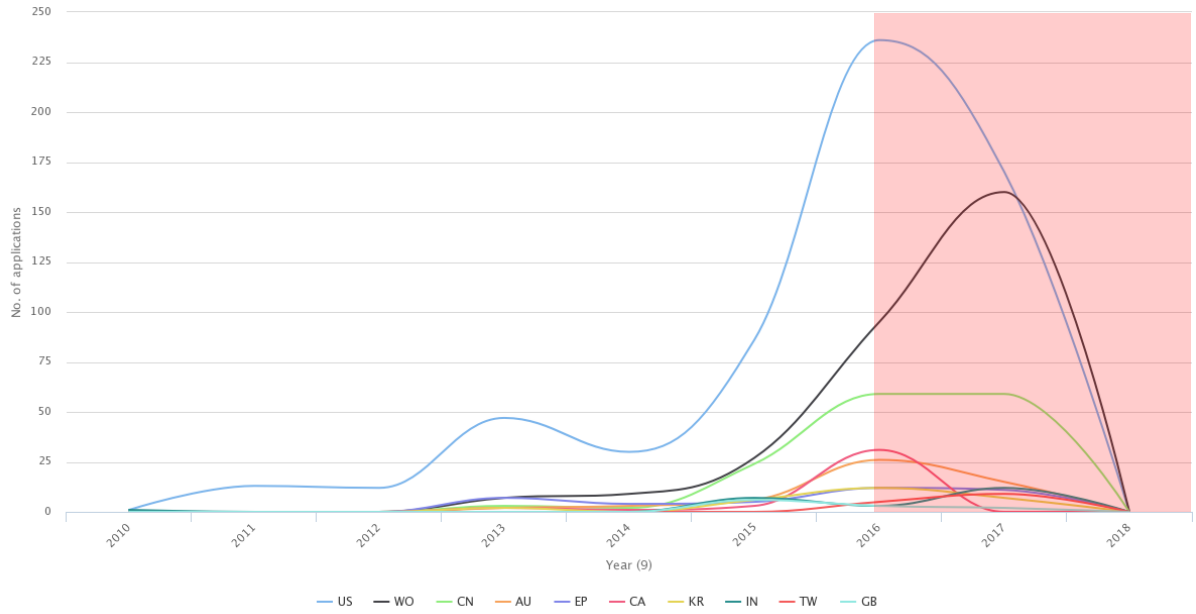

Figure 1 - Increase in Patent Applications for Blockchain or Distributed Ledger (Source: PatBase)

The adoption rate of the technology is also shown by the partnerships that are linked to various Blockchain-based initiatives, for example, Hyperledger (Hyperledger, Members, 2017). Large companies are starting to file for patents as the technology works its way into applications that benefit existing companies (Spencer & Belcher, 2017). An example of this is the patent on securities settlement using cryptographic currencies by Goldman Sachs & Co. LLC (US Patentnr. US9704143 B2, 2014). Also, a recently published patent application by Accenture shows the spread of the technology to other fields. Accenture have applied for a patent regarding the selection of commodity suppliers using Blockchain (US Patentnr. US20170206522 A1, 2016). These patents encompass a wide array of applications, with granted patents in the fields of computer access control, document verification, voting, identity control, trading, supply chain, IoT information distribution, and ticketing for venue access (Gatto, 2018). The high adoption rate of the technology is responsible for the high increase of the rate at which patent applications are filed, which means that intellectual property law firms are faced with an increasing amount of work in a field they are fundamentally inexperienced with.

1.2.2 Regulatory Change

In the field of Blockchain technology, due to the beforementioned extremely fast growth, the regulatory field is changing quickly (Ishmaev, 2017). This is most visible in cryptocurrencies, where regulatory bodies are trying to limit the anonymity of users in such a network. Also, in recent periods, the Initial Coin Offerings, a public crowdsale for Blockchain-based companies, have been subject to regulatory limitations (Hacker & Thomale, 2017). Changing regulations in any field of emerging technology has been a popular topic of consideration for scholars and people in business. Usually, the fast adoption of a technology implies that regulation is constantly changing (Khan & Hall, 2003). With Blockchain this is no different and the resulting regulatory shifts create an unstable environment for Blockchain inventions.

However, the fast growth and change of the technology is subject to criticism which has led to the push for an industry-wide standard. In a recent webinar by the Chartered Institute of Patent Attorneys (CIPA), it was presented that the International Standard Organization (ISO) is working on a standard for Blockchain (ISO, 2017). This could prove beneficial for applicants for intellectual property protection as regulations are more likely to be stable as a result of an industry-wide standard on the subject-matter. The development of this international standard by the ISO could induce regulatory stability (although this is not certain), but until the standard is made public and agreed on, the regulations are difficult to predict and will vary per country or region. The point being, whichever way the regulatory system goes, it is unpredictable at best. An example of this is the European Commission announcing their creation of a consortium to limit illegal activities on the dark web, by limiting the anonymity of crypto-currencies, while earlier that year, the same body announced that they would not institute any regulations limiting the use of cryptocurrencies (Redman, 2017). Fluctuations in regulatory policy could be limited by the adoption of a standard but a standard tends to take a while to be adopted, as various institutions are likely to propose a standard. A similar situation can be seen with the adoption of a standard for Internet of Things, where no conclusive standard has been adopted (Sharron & Tuckett, 2016).

1.2.2.1 Compulsory Licenses and FRAND-Terms

With the introduction of standard organizations and a subsequent increase in regulations, a new problem arrives, namely that of compulsory licences. A compulsory license is a license of which the proprietor cannot refuse the use, in exchange for a licence fee (Adelman, 1977). The proprietor of the intellectual property right is therefore obliged to allow the use of his invention, in contrast to the 'exclusive right' that an intellectual property right should transfer onto the proprietor. This is relevant to the above discussion as standard organizations often require a technology eligible for being subject-matter for a standard to allow access to their technology in the form of such a compulsory license. In essence, this is logical, if a technology is required following a standard (for instance 3G or Bluetooth), it would be ethically questionable to allow the proprietor to exclude certain parties of participating in the use of that technology. Imagine, for instance, that a proprietor of a technology compulsory for the 3G network would not allow Apple to use that technology, iPhones would no longer be able to communicate through the phone network, which could be mildly problematic for such a company.

To prevent a proprietor of a technology under a compulsory license to require extraordinary high fees for the license, the WTO (World Trade Organization) has included so-called FRAND (Fair, Reasonable and Non-Discriminatory) terms in their considerations on GATT (General Agreements on Tariffs and Trade), specifically in TRIPS (Agreement on Trade-Related aspects of Intellectual Property Rights) (Watal & Taubman, 2015). The FRAND-Terms have been developed through the history of Standard organizations, such as the aforementioned ISO, that have used it as a prerequisite for compulsory licenses (Contreras, 2015). What the FRAND-terms do, in practice, is spark a lot of discussion on what the definition of Fair, Reasonable and Non-Discriminatory actually is. Logically, the proprietors wish to get the highest possible compensation for their efforts while the entity using the standardized technology wants to use the technology without paying too much, as there are no other technical options as a result of the standard. These discussions about the FRAND-terms can be rather extensive and are likely to further delay the full

adoption of a standardized Blockchain approach. The FRAND-discussion is a main reason that the Regulatory Change has a negative effect on the relationship between emerging high tech and intellectual property law. That is, the discussion negatively impacts the time that is necessary to impose a standard, and as such, leaves the development of a technology unstructured for a longer period of time, thereby not allowing the law to adapt to the new technology.

1.2.3 Open Source

Blockchain is rooted in an Open Source-based community that prefer to share their work rather than keep it to themselves. However, 'Open Source' does not mean 'free to use in whatever way you deem fit'. In 1989, Richard Stallman, president of the Free Software Foundation, released the first version of the GNU General Public License (GNU GPL), which stated that any work, distributed under GNU GPL license, can be used free of charge but is subject to the same (free) licensing method (Stallman, 1989). Open Source advocates have long fought the possibility to patent software and have constructed a wide array of licences aiming to catalyse the 'openness' of software development (Evans & Layne-Farrar, Software Patents and Open Source: The Battle Over Intellectual Property Rights, 2004). Open Source is as such an often-misinterpreted notion as it does not allow for unrestricted use of published work. If a technology is developed using material under any licence of the Open Source Initiative (OSI, see List of Definitions), the claim to patentability is not lost but the ability to restrict access to the subject-matter is (Majerus, 2006). An Open Source licence states that the subject-matter should be accessible to anyone under the same license. So, as a developer produces software under an OSI license, he allows anyone to access and use the code, as with any other license. Anyone who decides to make use of this software must then allow it to be accessible to anyone as well, under the same licence, irrespective of the changes made to the software. One could argue that the sole purpose of a patent, controlling who can use the subject-matter, is lost with the introduction of Open Source subject-matter into the patent. There is a number of such Open Source platforms in the Blockchain industry, all using a wide array of different Open Source licenses, all with different advantages and disadvantages (Sharma, 2017). The use of licences will have an impact on the effectiveness of an IP protection strategy. For instance, if the code of the Blockchain contains a small portion of code that is licenced under a GNU GPL licence, the usefulness of a patent application will be limited.

The use of Open Source software has two sides, smart contracts and the Blockchain itself. First, smart contracts, which are the rules of a Blockchain, define the way in which the Blockchain operates. Smart contracts always need to be written to bring a new Blockchain-based idea on the market. You might imagine these smart contracts are easier to write if bits and pieces are taken from various libraries that can easily be accessed online because they are Open Source. After all, why write them yourself if the majority of the code is already available? This, however, means that the smart contracts themselves are no longer viable for patenting because the whole code now falls under an Open Source license and thus limits protection possibilities.

This brings us to the next point of attention; do you construct your own Blockchain or do you run the smart contracts on another Blockchain? Running your smart contracts on a Blockchain that you have not made yourself, will likely lead to licencing issues and possibly to the obligation to open up your own code as well. Examples of such Blockchains are Monax (Ramsay, 2017), HydraChain (HydraChain, 2015), MultiChain (MultiChain, 2015), and OpenChain, all with varying (or undefined) licensing terms. Monax falls under an Apache 2.0 License (Apache, 2004), HydraChain falls under the MIT License (Open Source Initiative, The MIT License, 2017), Multichain limits itself to trademark protection, and OpenChain mentions no licensing agreement on its website but as it turns out, runs under Apache 2.0 as well. While it is not important at this stage to go into detail about all of these Blockchains, it does demonstrate the variety with which OSI licences are used. To determine the value of running smart contracts on existing Blockchains, rather than creating a new one, one could assess the accessible Blockchains to determine their value in different use cases. This, however, would constitute separate research, which could be very

interesting but also very time consuming. In this research, we will use the creation of a Blockchain or the use of an existing one as given, with the inclusion of whether an OSI licence has been used. Also, seeing as the main effect of a patent is to hold the right to exclude certain entities from the intellectual property, an intellectual property right that uses OSI will not be valuable. As such, the appropriation of an IPR that uses an OSI-license will be advices against.

Considering the above, Open Source does not entail that subject-matter is no longer eligible for any protection by intellectual property law. Rather, the subject-matter for which protection is sought must not be dependent, with respect to its functionality of Open Source code. As explained above, Open Source licenses have a wide array of differences, which can be analysed to determine the viability of protection by intellectual property law. While research into the differences of these licenses and their effects on both innovation as a whole and specifically the protection of inventions is very interesting, this research will consider Open Source only relevant to the question of whether a proprietor created the invention himself. If Open Source material was used in the production of an invention, the distinction between what was produced by the proprietor and by others must be very clear. The subject-matter to be protected must achieve its objective without the necessity of the code produced by others.

1.2.3.1 Context of Blockchain Technology

The topic of this research is controversial with regard of the community in which many of the novel applications of Blockchain technology emerge (Pilkington, 2016). The developers of the technology are often of the opinion that the development of code should be done in collaborative efforts, the work of which is often protected from commercial application through Open Source licences, as mentioned. The fact of the matter is, however, that patent applications are being filed. Often by companies that have a commercial application in mind for technology that was partly developed, or at least conceptualized, by the very people opposing the protection of intellectual property rights for profitability. Although the distinction between distributed ledger projects and Open Source projects is often lost, they are vastly different (Evans, 2014). This is extremely important as the economic value of any project is highly dependent on the proprietor's ability to restrict the use of what was developed, which is severely limited by the use of Open Source licensing. As many of the projects surrounding the development of Blockchain technology so far have been aimed at collaborative efforts, the use of intellectual property rights is not likely to increase in the initial phases of development. However, as the technology is increasingly proving its worth and creating value for developers, the need for protection of its intellectual property rights is becoming more important, as shown in Figure 1.

Another consideration of the context of blockchain technology is its application in privacy matters. The topic of privacy is under pressure if peer-to-peer transactions were to be performed without any form of consensus mechanism that ensures privatized trust. Privacy, especially in the realm of internet traffic data is argued to be important by almost everyone, however, there seems to be little uniform understanding about the topic. This is exemplified by van den Hoven; *"The largest part of privacy research is concerned with the moral justification of a right to privacy. There is little agreement about the most adequate moral justification, but there is consensus among privacy scholars about the fact that privacy is important, and that privacy is vague, fuzzy, and hard to explicate or pin down."* (van den Hoven, 2008, p. 302). As a result, the use of these systems is increasingly important in settings where the digitized domain and personal data come together – which nowadays is almost everywhere. The requirement for the implementation of such a technology in matters where decentralized trust is important, requires the protection of the intellectual property rights of the inventions.

1.2.4 Jurisdictional Protection in Infringement Litigation

A big problem with the current state of intellectual property law concerns itself with the protection of technology that has global merit, not only with respect to distribution but also functionality. Intellectual property law is inherently jurisdictional and does not deal with global affairs very well. To put this into perspective, we consider company 1 that produces a hardware product in country A and wants to market in country A and country B. His intellectual property rights, once granted, protect him from other companies either producing or selling in country A and country B. This is the traditional function of the intellectual property system, albeit simplified to a considerable extent. In the case of Blockchain technology, these issues are not so clear. Again, we consider company 1, which produces a Blockchain-based system in country A and wants to market in country A and country B. In Country C, company 2 produces the exact same system and makes it available to anyone, and as such, has users in country B. In this case, it is not fully clear who is infringing and what right is being infringed. After all, anyone can access the system, and who actually owns a Blockchain-based system is difficult to determine as well. The accessibility of the system might influence the infringement of the technology, as well as the type of users in a network. However, the use and appropriation of the right intellectual property rights to cover this global affair is problematic. This problem will be dealt with by categorizing the technology per the characteristics that prove to be problematic and seeing how those issues are being dealt with by courts around the world.

As shown in figure 2, the above points are driving forces for the gap between emerging high technology, specifically Blockchain inventions, and intellectual property law. With reference to Blockchain inventions, the high rate of adoption leads to a shorter time for the law to adapt itself to the new demands that are brought forward by an innovative technology. The regulatory change adds to the uncertainty, and as a result to the ability of the law to adapt. The application of Open Source software to the development of many Blockchain inventions limits the use of intellectual property law to protect the Blockchain technology applications, especially with respect to copyright. And finally, the jurisdictional protection in infringement litigation means that once an intellectual property right is obtained, the enforcement of such a right is likely to be problematic as well.

It should be noted, with respect to the below figure, that the influencing factors for the gap between intellectual property law and Blockchain technology applications, do not affect the method with which the gap should be overcome. These factors are merely contributing factors to the relationship between the two. In section 7.2.2, it is explained that for the generalizability of this research, the driving factors over various technologies should be identified to allow for early recognition of problematic technologies. These are expected to at least comprise 1) the maturity of the underlying technology and 2) the demand for valorisation of the technology. This is required for answering the high-level problem statement (see section 1.5). The factors that influence the method for dealing with this gap will be explained in chapter 5.

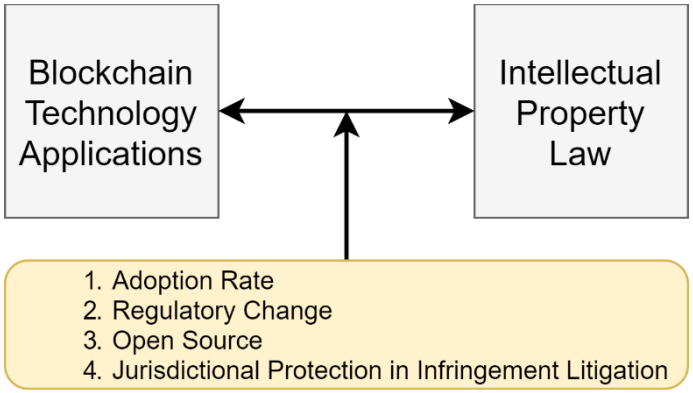

Figure 2 - Influences on Gap Between Blockchain Technology and Intellectual Property Law

1.3 Problem Statement

Let's say you are a patent attorney and you have a client that has a brilliant idea. He is using Blockchain technology to completely revolutionize the industry his company operates in. This idea, if done properly aims to create a huge strategic advantage for his company and promises to provide significant financial gains. You are tasked with protecting the idea against competitors who might want to do the same. As with all intellectual property protection, you will start analysing the idea, investigate its novelty, its inventiveness and its applicability in industry. Soon, you realise that things are not as simple as you would have hoped. What is Blockchain? Who owns a Blockchain? What are the effects of changing regulations in various fields of industry, now most evident in crypto-currency regulation (Joshi, 2017), regarding the use of Blockchain technology? What are the effects of Open Source structures in Blockchain technology? And how does infringement work if the patent is subjected to a litigation procedure? The problem owners are twofold, the patent attorney and the proprietor of the intellectual property, be it an individual or a company, both will benefit to a solution to the following problems.

In the technology itself, it is difficult to define ownership. Everyone has access to the entire system, there is no part secret or centralized. That begs the question if the technology, once in place, actually has any merit for ownership. It might be argued that, because the system has no centralized institution, the system does not 'belong' to anyone, it is created but not owned. While Blockchain is an excellent tool to verify ownership of tangible assets, the question of who owns the Blockchain itself, paradoxically, remains widely disputed. The ledgers, the blocks of data that every node in a system must have to verify other transactions, do not belong to the creator of the Blockchain. Frankly, the system that is built by the creator of the Blockchain is designed to be adapted by every transaction in the system and as such, is very hard to define claims to. What aspects to define claims for, is an example of a strategic choice that has to be made by a patent attorney.

The problems that are being faced can be divided into two levels of specificity, referencing to the managerial relevance and the academic relevance of the research (see section 1.4 and section 1.5). On a low level, encompassing managerial relevance, the problem is lack of knowledge about the effectiveness of protection strategies resulting in difficulties to advice clients on methods to protect intellectual property rights of Blockchain technology applications. On a high level, as will be more elaborately explained below, the problem is a lack of connection between the law and emerging technology (Durell, 2000) (see figure 5).

1.3.1 Research Objective

The goal of this research is:

> *To provide a framework that might aid patent attorneys, and by extension, the proprietors of intellectual property rights, in determining how to protect the intellectual property of Blockchain technology applications given the characteristics of the technology, and as such, to develop a handle on closing the generic gap between emerging high technology and intellectual property law that manifests itself in areas of technology marked by high adoption rate and a high degree of innovativeness.*

Based on the law and literature that includes both the technology and the law, a theoretical decision-making framework can be constructed. This theoretical decision-making framework will then be tested by means of case comparison of appeal cases in the granting procedure as well as during infringement litigation, guidelines and a patent review. The result of this research into the effectiveness of the protection strategies in appeal and infringement litigation will show limitations in the decision-making framework and allow for improvements.

1.3.2 Research Questions

To accomplish the aforementioned research objective, what this thesis aims to address, is:

Research Question:

How can a validated decision-making framework be constructed for protecting intellectual property of Blockchain technology applications, using current intellectual property law, given key characteristics of the Blockchain technology applications of which the intellectual property must be protected?

To answer this question, we must first answer the following four sub-questions:

Sub Question 1

What type of intellectual property right is able to protect intellectual property of Blockchain technology applications or Distributed Ledger technology?

First, we must determine what intellectual property rights qualify for protecting Blockchain technology applications. To prevent a full analysis of everything that is involved with intellectual property law, it would be advised to adopt a pragmatic view on the available tools and identify what is useful before an in-depth analysis performed. After the intellectual property right best suited for the technology has been identified, the possibilities within this intellectual property right can be identified.

Sub Question 2

What are the strategic options in this type of intellectual property right?

The second sub question concerns itself with the possibilities that a patent attorney or a proprietor of intellectual property is faced with. These options might concern themselves with, but are not limited to, jurisdictional, monetary, and technical variations. The first two sub questions deal with the law, which prescribes what the available intellectual property rights are and what the possibilities are therein. Once the law has been analysed, the technology can be analysed, and consequently linked to the law.

Sub Question 3

How do characteristics of the Blockchain technology applications and its proprietor affect the choices in the protection strategies?

The third sub-question deals with the technology that needs protecting. These characteristics will be the input to the decision-making framework. An answer to this question provides the basis for the Theoretical Decision-Making Framework. It requires analysing the complex relationship between the characteristics of the technology the proprietor wishes to protect and the choices that have to be made to do so, based on the current state of intellectual property law. With regard to this sub-question, connections between specific characteristics of the technology and the resulting conclusions from the law must be identified. Where applicable, characteristics that are not relevant to the workings of the law could be attributed to preferences of the proprietor of the intellectual property right.

After the first three sub-questions, a theoretical decision-making framework will be constructed, based on the technological characteristics of Blockchain technology applications and the law. Next, the theoretical decision-making framework will be tested.

Sub Question 4

What adaptations can be made to the Theoretical Decision-Making Framework, based on patent analysis, case law, and guidelines?

Specifically, the fourth sub-question will be answered by referring to the following related questions:

Sub Question 4A

What are the likely developments of the granting rate of Blockchain-related patents?

Sub Question 4B

What part of the Blockchain technology application is mainly included in the subject-matter of granted patents?

Sub Question 4C

What claim formulation – with respect to preambles and transitional phrases – are used in the claims of granted patents?

Sub Question 4D

What are the key decisions that influence the filing route or the part of the technology to be protected of a Blockchain technology application patent application in appeal, opposition, or infringement case law?

Sub Question 4E

What are the differences between the Guidelines for claim formulation and the Theoretical Decision-Making Framework?

The modifications to the theoretical decision-making framework will be implemented as to include deviations from the initial outcome, based on the above sub-question(s) 4, which will lead to a validated framework. This will answer the main research question.

To acquire the knowledge necessary to answer these questions, case law and patent databases can be used in combination with literature research. Later in this research proposal, it will be shown how these are used to answer specific questions. In short, literature and law will allow for the development of a theoretical framework, and case law, patent analysis and guidelines could provide insight into the level of effectiveness of protection strategies so as to validate the theoretical framework (see figure 3). Patent databases, such as PatBase and Google Patents, can be used to provide insight into what components of a Blockchain technology application are usually protected, using what mechanisms. In chapter 3, an elaboration on the development of the answers to the sub questions will be provided.

The below figure shows the relationship between the sub-questions and the main research question, with the inclusion of the development of a Theoretical Decision-Making Framework and the subsequent improvement of said Framework, as described under sub-question 4 in the above section (see figure 4).

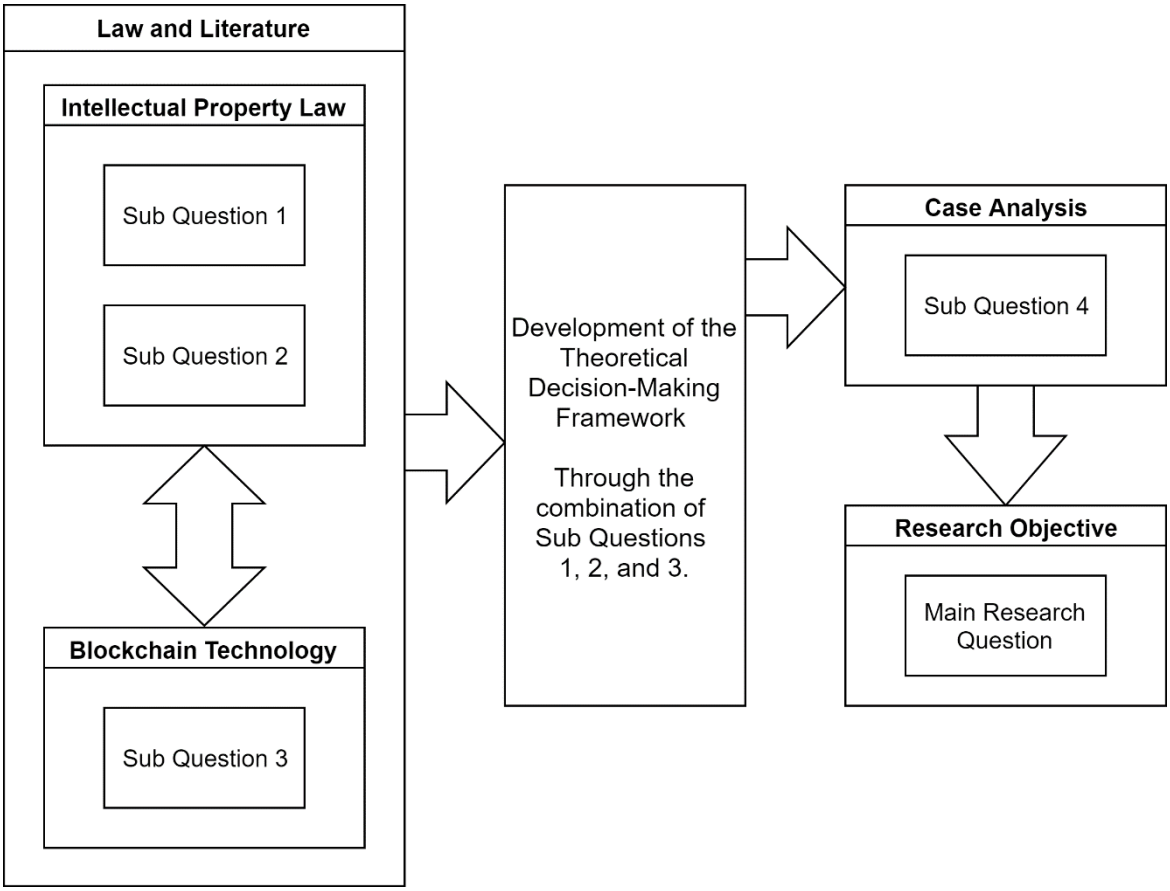

Figure 3 - Conceptual Research Framework

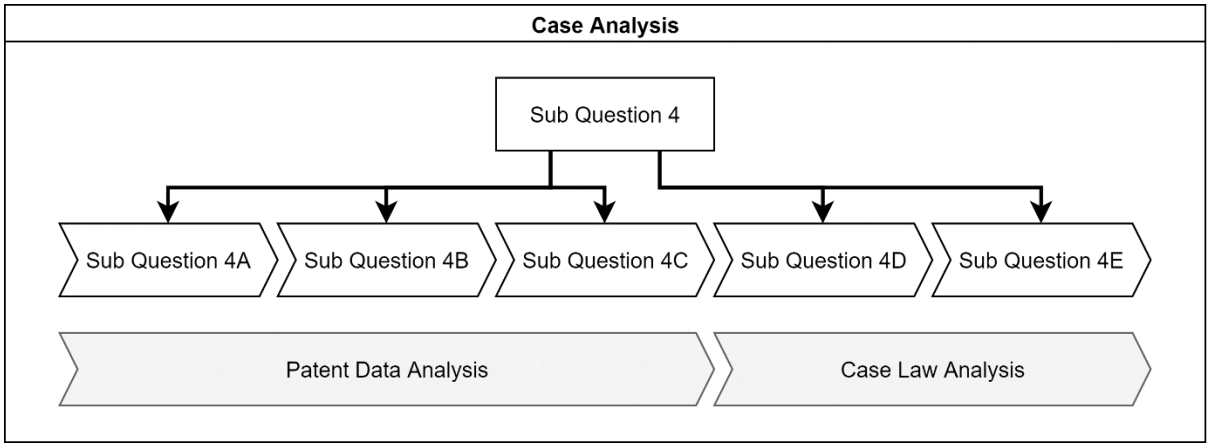

Figure 4 - Expansion of Sub Question 4

1.4 Managerial Relevance

As technology is developing at a fast pace, which has been historically the case, there is a need for adaptations of IP law to changes with respect to managerial strategy that are necessary to survive in a dynamic competitive landscape (Bettis & Hitt, 1995). Because the current state of intellectual property law is said to be limited in its ability to protect the latest inventions in the digitized environment, uncertainty is increasing about what the best protection mechanisms are. As many intellectual property law firms are struggling on advising their clients on the protection strategies of Blockchain technology applications, research into the effectiveness of protection strategies will be very valuable. The problem of the difficulty to advise on effective protection strategies for Blockchain technologies is an industry-wide problem that affects intellectual property law firms as well as entrepreneurs, companies, and patent offices. One such an intellectual property law firm is HOYNG ROKH MONEGIER, based in Paris, with an office in Amsterdam (for more information, see Glossary). For HOYNG ROKH MONEGIER, an assessment of the effectivity of protection strategies concerning intellectual property rights of Blockchain technology applications can be very valuable. First, as a way to advise on intellectual property protection strategies and second, as a way of client acquisition. But, the solution would not only benefit HOYNG ROKH MONEGIER, it would benefit the industry as a whole as the protection strategies adopted by IP law firms and their clients could become more structured. A decision-making framework for determining a protection strategy, given key characteristics of the Blockchain technology application, would be a contributor to the effectiveness with which intellectual property law firms operate. As a result of that, the costs associated with the protection of intellectual property rights of Blockchain technology applications are likely to diminish as it becomes clearer what effective strategies are.

Currently, patent attorneys have a limited view on how effective certain types of protection are. The developments described in section 1.2 have led to a situation where a patent attorney is faced with the task of protecting an invention without knowledge about the effectivity of the type of protection he is implementing. First, a patent attorney has to its disposal, several types of law that could protect an invention (i.e. copyright, patents, trademarks, and confidentiality). Second, certain aspects of the invention might be eligible for protection by one of these types of law. For instance, the code can be protected by copyright and confidentiality, the Graphical User Interface by copyright (and maybe design rights) and the inventive step, should there be one, can only be protected by a patent. A patent attorney or the proprietor of the invention has to make decisions regarding these choices, based on the characteristics of the Blockchain technology application of which he is tasked with protecting the intellectual property. From literature, it seems patents are now the predominant protection mechanisms for Blockchain technology applications (Guo, 2017). However, it remains to be seen whether this approach will prove to be most valuable for protecting the intellectual property rights of Blockchain technology applications. The core focus of this research is twofold; the types (and combinations) of protection mechanisms to protect intellectual property rights on the one hand, and the characteristics of the technology that affect the effectiveness of the chosen protection mechanism. Put more simply, the law and the technology.

In addition to the benefits for IP law firms, actors looking to protect their IP rights can use the decision-making framework as a tool to become more knowledgeable about ways to protect their intellectual property. The transferral of knowledge of the product from the inventor to the attorney who writes the claims can be a lengthy process, especially with a difficult concept such as Blockchain technology. If clients of IP law firms have the possibility to emerge themselves in the protection possibilities before speaking to a patent attorney, they efficiency of the process of filing for protection for intellectual property rights will increase.

Another crucial aspect of this research to the managerial implications is the cost of misplaced patents. If the quality of a patent is low, wrongful granting can cause significant problems on two aspects. First, the costs of a wrongfully granted patent can cause misplaced allocation of capital to the underlying intellectual assets and lead to investments by the proprietor in a field where protection is below par in case of litigation. Second, if a patent is granted without it being valid, it may hamper entrepreneurial aspirations to technological development while the basis of the fear of infringement is in fact absent (Philipp, 2006). A solution to the above problem statement should help structure the process of patenting as both proprietor and representative would be better informed with regard to the possibilities and effects of this type of protection for intellectual property rights. And in addition to this, the only way the intellectual property system can function as intended by its creators is when the connection between the technology and the law is optimal. Fundamentally, this would help reduce the costs of innovation in the current state of intellectual property law. Scientifically, the research that has been performed in this field, often points towards the need for changes of the law. While this may bring the law and the technology together at some point, history tells us that changing the law is a rather lengthy process. This research aims to address the way in which the law is dealt with, rather than change it, which allows for a far more practical solution to the problem as described above.

1.5 Academic Relevance

In the below section, the literature is used will be shortly presented in table 1. This is subsequently elaborated on more extensively and the contents of the literature is highlighted, depending on its relevance for this research.

Table 1 - Literature for Academic Relevance

Author(s)	Year	Title	Journal	Subject
Aghion, Howwit, & Prantl	2013	Revisiting the Relationship Between Competition, Patenting, and Innovation	*Advances in economics and econometrics*	Positive relationship between IP law and innovation incentives
Arena & Carreras	2008	The business of intellectual property	*Oxford University Press*	Indicators of value of a patent
Bessen & Hunt	2007	An empirical look at software patents	*Journal of Economics and Management Strategy*	Influence of IP law on R&D
Bessen & Maskin	2009	Sequential Innovation, Patents and Imitation	*The RAND Journal of Economics*	Effects of IP law in a static and dynamic world
Durell	2000	Intellectual property protection for computer software: how much and what form is effective?	*International Journal of Law and Information Technology*	IP Law and Software
Evans & Layne-Farrar	2004	Software Patents and Open Source: The Battle Over Intellectual Property Rights	*Virginia Journal of Law and Technology*	IP Law and Software
Guellec & van Pottelsberghe de la Potterie	2000	Applications, grants and the value of patent	*Economic Letters*	Value of individual patents
Jewkes	1958	The Sources of Invention	*N/A (Book)*	Validity of Patent System
King	2018	The Value of Intellectual Property, Intangible Assets and Goodwill	*N/A (WIPO)*	Knowledge valorization
Machlup	1958	An economic review of the patent system	*US Government Printing Office*	Economy of Patents
Philipp	2006	Patent filing and searching: Is deflation in quality the inevitable consequence of hyperinflation in quantity?	*World Patent Information*	Trade-off between quantity and quality in the patent system
Pilch & Shalloe	2005	Patent information in a changing world: Perspectives from a major patent office	*World Patent Information*	Effect of globalization and complexity on IP law
Plant	1934	The Economic Theory Concerning Patents for Inventions	*Economia*	Validity of Patent System
Porter	2008	The five competitive forces that shape strategy	*Harvard Business Review*	Competition

Author(s)	Year	Title	Journal	Subject
Schoch-Grübler	2004	Maggots in paradise - work for the gardeners	*World Patent Information*	Effects of globalization on IP law
Sullivan	2000	Value Driven Intellectual Capital: How to Convert Intangible Corporate Assets into Market Value	*N/A (Book)*	Firm value determination based on intellectual assets
Wurzer, Grünewald, & Reinhardt	2012	Valuation of Patents	*N/A (Book)*	Indicators for value of patents as a determination of market value for the proprietor

The above problem (section 1.3) can be formulated on a higher level as well. For a long period of time, the validity of the patenting system has been questioned by scholars and actors from industry (Plant, 1934); (Machlup, 1958); (Jewkes, 1958). The question whether it actually promotes innovation and creates value remains disputed to this day (Bessen & Maskin, 2009). All referenced writers advocate against the use of a patenting system and identify a lack of connection between current technology and intellectual property law. This is highlighted from two perspectives, the technology and the law. First, technology is highly adaptive, it changes constantly which results to the fundamental inability of patent law to keep up with the changing nature of what it is supposed to protect. Technology leads to globalization and consequently to complexity of information flows and a demand of an increasingly intricate legal system (Pilch & Shalloe, 2005). Second, the law is rigid, it does not keep up with the technology as much as it should and should, to better suit the demands of the technology, change, not just once, but constantly (Philipp, 2006). What fundamentally creates the gap between emerging high technology and intellectual property law, it seems, is the nature of the two. Technology being flexible, hard to predict and unstable, while the law is rigid, hard to change, and stable by default – after all, unstable law would hardly be functional. The problem arises as the result of the interplay of two generic drivers, namely the maturity of the technology and the demand for valorisation of the technology. The demand for valorisation of the technology, as a result of for instance the adoption rate or the wide applicability, results in the increase of patent applications. If the law had no time to adjust to the new technology because it is still immature, the aforementioned gap between emerging high technology and intellectual property law surfaces.

The connection between the technology and the law, or better put, the lack thereof, allows for two options. Either abolish the whole patent system, as many have advocated, or close the gap between technology and the law. To abolish the patent system would entail quite disastrous consequences for the economic system as so much of companies' values, and increasingly so, is built on intangible assets. Knowledge and the procurement and commercialization thereof is a fundamental part of the economic society we live in. We go back to the abovementioned scholars, who state that *"But since we have had a patent system for a long time, it would be irresponsible, on the basis of our present knowledge, to recommend abolishing it."* (Machlup, 1958, p. 80) and *"It is almost impossible to conceive of any existing social institution so faulty in so many ways. It survives only because there seems to be nothing better."* (Jewkes, 1958, p. 254). Even with regard to the software industry, where patents have been widely opposed for a prolonged period of time, the value of the patent system is subscribed, and reforms are proposed, rather than complete abolition of the system (Evans & Layne-Farrar, 2004). This leads to the retention of the benefits while minimizing the negative effects that might be attributed to the system of intellectual property law, in particular with regard to software. These statements clearly stipulate the biggest reason for the existence of the patent system, it can simply not be removed.

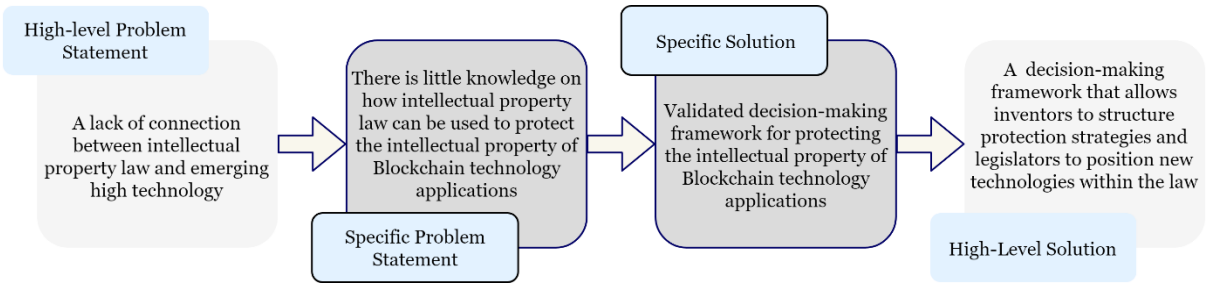

Figure 5 - Academic Relevance

It follows that there is a need to find a better 'fit' between emerging high technology and intellectual property law as patents have a positive effect on innovation incentives (Aghion, Howitt, & Prantl, 2013). This positive effect, however, is argued to only exist if the technology to be protected and the law that should protect it show a degree of uniformity between one another (Schoch-Grübler, 2004). To solve the scientific problem, we must look at a specific problem statement, such as the one described above. Once a satisfactory solution for the specific problem statement has been found, it can serve as a tool to develop a high-level solution. Namely, a decision-making framework that allows inventors to structure protection strategies and legislators to position modern technologies within the law so as to diminish the generic gap between emerging technologies and intellectual property law (see figure 5).

1.5.1.1 Value and Effectivity of Protection of Intellectual Property Rights

In addition to the above, in scientific literature the effectivity of IP protection through intellectual property rights has been researched only to a limited extent. The main focus of papers in this field of research have been to assess the effectiveness of the patent system as a whole to, for instance, economic growth in a particular sector or their influence on R&D (Bessen & Hunt, 2007). Research into the effectiveness of protection mechanisms in Intellectual Property, based on results of infringement litigation or appeal cases in the granting procedure of a patenting process does not seem to exist. The valuation of companies is founded to an increasing extent in the appraisal of intangible assets, of which intellectual property is a key component (King, 2018). There has been research into determining the value of individual patents (Guellec & van Pottelsberghe de la Potterie, 2000), based on characteristics of the patent, as patents are now often used as indicators for the value of a firm (Sullivan, 2000). These studies cover a wide range of indicators of patent value on a higher level than the functional implications of patent protection. Following the five forces by Porter (2008), many authors identify the value of patents along the impacts and functions within the five forces. On the negotiation power of customers, the impact is the exclusivity of the characteristics of a product, through the patent function of protection. On the threat of new entrants, the patents realise value by blocking new entrants, which leads to the defence of the market share of the proprietor. The threat of substitutes is mitigated by patents through the creation of circumvention incentives. The negotiation power of suppliers is lowered by creating compatibility with a standard by licencing the patent. Finally, the competitors are confronted with a patent and will have an incentive to cooperate. All of these points are key in creating value attributed to the patent (Arena & Carreras, 2008, p. 147). Furthermore, key indicators to the value of a patent are given as being, amongst others, the age of the patent, the number of backward and forward citations, the breadth of the patent right, the inventors, family size, choice of procedure, legal disputes, various text elements, the number of claims, and the market value of the proprietor (Wurzer, Grünewald, & Reinhardt, 2012, pp. 226-248). However, none of these provide insight into the ability of patents to actually protect the intellectual property rights. The generic conclusion of much of the value determination research lies beyond the assumption that the patent will be successful in protecting the intellectual property rights in case of litigation. The ownership of a large patent portfolio, with excellent patents, has no value if the lawyer

representing the proprietor in litigation has no idea what he is doing. Seeing as an intellectual property right is an exclusive right, the use of said right, in a way that is profitable, is the only way value can actually be created. The mere existence of a patent portfolio does not valorise the full potential of valorised knowledge.

Due to the elevated level of attention and the subsequent demand for protection of IP rights, the protection of Blockchain technology applications is an excellent starting point for this research. Usually, the law provides a good indicator of the effectiveness of a protection strategy. After all, a protection strategy will not be effective if the claims are in conflict with the law and as such hamper the validity of an IP right. However, as mentioned, the law does not seem to be equipped to deal properly with the protection of IP rights of software, let alone Blockchain technology (Durell, 2000). The effectiveness of a protection mechanism can no longer be determined by looking at the law itself, it will need to be combined with an assessment of how these protection mechanisms hold up in real life. This is the case for technologies that have a high adoption rate and are disruptive to some degree. Logically, these are the technologies that the law is least prepared for, specifically, Blockchain technology is such an example.

1.6 Thesis Structure

In the following chapter (chapter 2), a literature review will be provided in addition to the necessary background information on the fields of both intellectual property law and Blockchain technology. In this chapter, literature on Blockchain technology will be briefly discussed, after which an in-depth explanation of Blockchain technology will be provided, using said literature. Next, intellectual property law will be elaborated more extensively than in chapter 1, and with more inclination towards the scope of this research. It will discuss the types of intellectual property law and the main institutions so as to provide an understanding of what organizations and what laws this research will incorporate. On the topic of intellectual property law, other topics will be highlighted as well, namely the effect of intellectual property rights on innovation and the value of intellectual capital, as mentioned briefly in section 1.3.3 in the introduction. Finally, literature combining the two subjects to a certain extent will be discussed.

In chapter 3 the methodology of the research will be described. The development of the theoretical decision-making framework, along with the determination of underlying relationships will be explained first, after which the validation of the theoretical decision-making framework is elaborated. Also, the available sources and research material will be discussed.

In chapter 4 will deal with sub questions 1 and 2 so as to identify the intellectual property right most suitable for the protection of intellectual property associated with Blockchain technology and subsequently with the choices that can be made in that intellectual property right. These will serve as a foundation of the theoretical decision-making framework. To do this, the technology will be analysed so as to identify the parts of the technology that might be eligible for protection through the adoption of various types of intellectual property rights.

In chapter 5 the theoretical decision-making framework will be constructed by answering sub question 3. This allows for a full overview of the relationships between the Blockchain characteristics and the choices identified in chapter 4. Once these relationships have been identified, either through use of literature or intellectual property law, they will be combined into a theoretical decision-making framework which will then be tested and validated.

In chapter 6 the theoretical decision-making framework, as presented in chapter 5 will be tested in accordance to either case law of intellectual property rights of Blockchain technology applications or comparable fields of technology, in cases regarding infringement litigation or appeal. This will allow for the creation of a decision-making framework that is validated, rather than one that is only built on the foundations of literature.

In chapter 7 the conclusions and discussion on the results of the research will be discussed. An overview of the principles of the decision-making framework and the implications will be provided, along with a critical note to the validity of the results and recommendations for further research. Finally, the connection between the M.Sc. program Management of Technology and this research will be highlighted.

1.7 Summary of Introduction

This research aims to provide a framework that might help patent attorneys, and by extension, the proprietors of intellectual property rights, to determine how to protect the intellectual property of Blockchain technology applications. Practically, this entails providing a handle on the use of intellectual property law to protect Blockchain inventions. Scientifically, this research might provide a method of closing the generic gap between emerging high technology and intellectual property law.

Due to the fundamentally flexible nature of emerging high technology and the equally fundamental rigid nature of intellectual property law, the connection between the two in an early phase of development for such a technology is difficult to accomplish. However, the valorisation of knowledge is very important to the value of a company and therefore must be achieved, regardless of the lack of connectivity between the technology and the law.

The subject of this research, Blockchain technology applications, is an excellent example of such a technology, not in conformity with the law for four reasons. First, the adoption rate of the technology is high, which leads to time-pressure on changes in the law which will take time. Second, the technology is subject to many regulatory changes and criticism, thereby creating more uncertainty over the development of the technology, and as such a longer period wherein the law cannot adapt to the technology. Third, the technology is rooted in an Open Source community, which leads to limited possibilities for the appropriation of intellectual property rights and of which the users might actively resist the appropriation of IPRs. Fourth, the nature of the technology leads to problematic situations with jurisdictional infringement as the law is jurisdictionally bound and the technology has the potential of being fully globalized.

The use of Blockchain technology applications as the subject of this research is, based on the above, an excellent starting point for the development of a method for closing the gap between emerging high technology and intellectual property law.

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2 Literature Review

"In my view, the composer, just as the poet, the sculptor or the painter, is in duty bound to serve man, the people. He must beautify life and defend it. He must be a citizen first and foremost, so that his art might consciously extol human life and lead man to a radiant future."

– Sergei Sergeyevich Prokofiev –

The two major subjects of this research are quite illusive, Intellectual Property Law and Blockchain technology are both very specific subjects that not many people understand fully. Furthermore, experts in the field of either intellectual property law or Blockchain are likely not to be an expert in the other field. This section will provide the reader with background in both intellectual property law and Blockchain technology, the foundations of which are necessary for this research. First, the sources will be discussed for intellectual property law, after which a more detailed description will be provided about intellectual property law, including the most important types of law and institutions. As later will be explained, in chapter 4, the biggest focus of this research will be with regard to patents as that is the type of intellectual property right that is best suited to protect the intellectual property rights of Blockchain technology applications. So, the focus in this section will be on patents and their most important characteristics. Once a description has been given about intellectual property law, its rights and its institutions, a detailed description about Blockchain technology will be provided. First, by providing the used literature sources and then by going into detail about the fundamentals of Blockchain technology, and the adaptations to the consensus mechanisms that exist.

The literature has been selected using a backward iteration snowball method (Wohlin, 2014), starting from Ishmaev (Blockchain technology as an institution of property, 2017), Guo (Blokchain Receipts: Patentability and Admissibility in Court, 2017), Pilkington (Blockchain Technology: Principles and Applications, 2016), Fairfield (BitProperty, 2014) and Jalfin (Protecting IP in the Blockchain Sector, 2017). This has led to the below literature review of both intellectual property law and Blockchain technology.

For both subjects, an overview of reviewed literature will be discussed first, after which a more elaborate explanation of the respective subject will be provided. This will be done per subject-specific literature first, after which the combination of the two subjects will be considered. There is a relatively small amount of literature on the combination of intellectual property law and Blockchain, the literature that is available often concerns itself with the use of Blockchain technology in intellectual property, rather than the use of intellectual property on Blockchain (Zeilinger, 2016). To connect the two subjects through literature review, literature of intellectual property law and its principles regarding intangible assets and inventions, such as software protection, will be discussed, from which lessons might be derived. Although software or computer programs is a relatively mature technology group in the field of intellectual property law, a current assessment of the technology and the application of intellectual property law to it, might provide assumptions about the course of intellectual property law with respect to Blockchain technology applications.

2.1 Intellectual Property Law

As briefly introduced, the first section to be discussed concerns itself with intellectual property law. This section will first discuss literature sources for the literature review of intellectual property law, after which the different types of intellectual property rights will be discussed. Furthermore, the concept of property will be discussed, in particular in relation to data. Also, the interplay between intellectual property law and innovation will be highlighted so as to provide background to the aforementioned high-level problem statement in the previous chapter. Finally, a disquisition on the institutions imperative to the implementation of these intellectual property rights, specifically with respect to this research, will be provided.

2.1.1 Literature Sources for Intellectual Property Law

The below set of literature will be further elaborated on in the following section, see table 2. These sources will provide the necessary information for the abovementioned points of consideration.

Table 2 - Literature for Intellectual Property Law

Author(s)	Year	Title	Journal	Subject
Aghion, Howwit, & Prantl	2013	Revisiting the Relationship Between Competition, Patenting, and Innovation	*Advances in economics and econometrics*	Positive relationship between IP law and innovation incentives
Bessen & Maskin	2009	Sequential Innovation, Patents and Imitation	*The RAND Journal of Economics*	Effects of IP law in a static and dynamic world
Chisum	1997	Normative and Empirical Territoriality in Intellectual Property: Lessons from Patent Law	*Virginia Journal of Intellectual Property Law*	Globalization and IP law
Evans & Layne-Farrar	2004	Software Patents and Open Source: The Battle Over Intellectual Property Rights	*Virginia Journal of Intellectual Property Law*	IP Law and Software
Foucault	1977	What is an author?	*Language, Counter-Memory, Practice*	Authors and Ownership
Hall	2007	Patents and Patent Policy	*Oxford Review of Economic Policy*	History and future of IP law
Hegel	1991	Elements of the philosophy of right	*Cambridge University Press*	Property Definition
Jay & Taylor	2013	A case of champagne: a study of geographical indications	*Corporate Governance eJournal*	Geographical Indications
Jell	2012	Patent Filing Strategies and Patent Management: An Empirical Study (Ch. 2)	*N/A (Book)*	In-depth review of literature about the patent system
Jewkes	1958	The Sources of Invention	*N/A (Book)*	Validity of Patent System
Kostkova, et al.	2016	Who Owns the Data? Open Data for Healthcare	*Frontiers in Public Health*	Data Ownership
Kur & Dreier	2013	European Intellectual Property Law	*N/A (Book)*	European IP Law

Author(s)	Year	Title	Journal	Subject
Levitin & Redman	1998	Data as a Resource: Properties, Implications, and Prescriptions	*MIT Sloan Management Review*	Data valorisation
Penner	1997	The idea of property in law	*Oxford University Press*	Property Definition
Pilch & Shalloe	2005	Patent information in a changing world: Perspectives from a major patent office	*World Patent Information*	Effect of globalization and complexity on IP law
Sullivan	2000	Value Driven Intellectual Capital: How to Convert Intangible Corporate Assets into Market Value	*N/A (Book)*	Intellectual Capital
Wallis & Borgman	2011	Who is Responsible for Data? An Exploratory Study of Data Authorship, Ownership, and Responsibility	*Proceedings of the Association for Information Science and Technology*	Data Authorship
Wurzer, Grünewald, & Reinhardt	2012	Valuation of Patents	*N/A (Book)*	Intellectual Capital and drivers for value of patents

European Intellectual Property Law by Annete Kur and Thomas Dreier will provide a foundation for intellectual property law in Europe, a preliminary analysis of mechanisms and the adherent case law (Kur & Dreier, 2013). Intellectual property law is a field of study that has not been dealt with extensively in combination with technology management and computer sciences in any field of study. This book will add to the necessary knowledge needed to provide answers to the proposed research questions. It should be noted, that while this book concerns itself with intellectual property law in Europe alone, the lessons learnt do not limit themselves to this jurisdiction as almost all countries employ patent law based on WIPO conventions. For the basis of IP law, it would suffice to use Kur and Dreier. Most information about intellectual property law in this research is based, at least in part, on the writing of Kur and Dreier.

For an insight into the effects of certain strategies on the value of the protected asset, we can draw from the book by Patrick Sullivan, *Value Driven Intellectual Capital: How to Convert Intangible Corporate Assets into Market Value*. It describes how the possession of intellectual property can create value for a firm by use of the property rights as a strategic advantage (Sullivan, 2000). In addition to this, *Valuation of Patents* (Wurzer, Grünewald, & Reinhardt, 2012) will be used to provide an insight into the value of intellectual capital, in particular that of patents. These books provide an overview of what drives the value of a patent. In addition to this, the books will allow for an identification into the flaws associated with the patent system and partly explain the foundation of this research (also see section 1.3.3).

A generic overview of the patent systems, including its history and considerations regarding the effect on innovation is provided by Bronwyn Hall, who shows that the activity and effectiveness on innovation incentives of patents vary strongly over fields of technology (Hall, 2007). This paper also identifies the problems associated with a high degree of heterogeneity in patent applications and responses to offices, giving rise to vastly different chances of success at various locations (also see section 6.1.1), even if the principles of underlying law, as put forward by WIPO, are essentially equal. This, along with the subjectivity of law and the increasing pressure on inventive step leads to a skewed field of intellectual property law which no longer allows for the same levels of intellectual property protection for all applicants. The overlying structure of intellectual property law (TRIPS, see List of Definitions) does not

adequately provide homogeneity in the field of intellectual property law. The resulting heterogeneity is not necessarily negative but has to be pointed towards equality over technologies as the expansion of patenting activity is increasing. In addition to the paper by Hall, the second chapter of *Patent Filing Strategies and Patent Management: An Empirical Study* will be analysed (Jell, 2012). This chapter, written by Florian Jell, provides background information on the patent system and various considerations regarding its efficiency without going into details about his own perspective and as such provides an excellent overview of literature of the patent system.

References will be made to the European Patent Convention (EPC), proposed by the European Patent Organization (EPOrg). The EPC constitutes the European Patent Law and especially article 52 is important to consider at this stage, as it partly explains the ambiguity surrounding patentability of Blockchain applications. Article 52, Patentable Inventions, states that "patents shall be granted for any inventions, in all fields of technology, provided that they are new, involve an inventive step and are susceptible of industrial application.", which would mean that Blockchain is patentable. It then goes on to explain what is excluded on the basis of not being regarded as an invention, under which programs for computers fall. However, the final paragraph states that the limitations only apply to the subject-matter 'as such', which indicates that a patent can be granted if the subject-matter constitutes a technical solution to a technical problem. This is where interpretation of the law and ambiguity about the subject-matter, based on subjective assessment of the claims come into play. The law no longer prescribes the level to which certain technologies are patentable in a concise, objective way. This subject will further be analysed in chapter 4.

The most important articles of the European Patent Convention (EPC) that provide additional insight in the workings of European Law are provided in Appendix D. The European Patent Convention provides an example of law, it will be complemented by national patent acts and Worldwide acts in the first stages of the thesis if they deviate from the EPC. The EPC provides a good insight in the general workings of the national patenting systems as well because of article 66 – Equivalence of European filing with national filing (see Appendix C).

Finally, the World Intellectual Property Organization (WIPO), a subsidiary of the United Nations, provides some information on software patenting, in which they highlight the attempts within the European Union to unify patentability of computer-implemented inventions and the distributed views of European stakeholders as a result of those attempts (WIPO, Patenting Software, 2018).

2.1.2 Types of Intellectual Property Rights

This section will provide an introductory overview of intellectual property law and its most important types of intellectual property rights. First, copyrights will be discussed, along with the subject matter it aims to protect, the practical implications of such protection and the regulatory system behind these rights. Along the same lines, trademarks will be discussed, followed by industrial designs, geographical indications and patents. As previously mentioned, the main intellectual property rights that will be discussed in this research are patents, which for that reason will be elaborated on slightly more extensive than the others.

2.1.2.1 Copyrights

Copyrights provide protection for literary and artistic work. Generally, anything that anyone writes falls under copyright, if it is the result of a creative process. In other words, if you were not the first to produce the artistic or literary work, you are not allowed to use it. There is no need for registration of the copyright, as soon as anyone writes anything, it is automatically protected by copyright. The period of protection of copyright is very long as well, it lasts no less than fifty years after the death of the creator.

Copyrights are regulated as a result of treaties administered by WIPO. Most notably the Berne Convention for the Protection of Literary and Artistic Works, the Rome Convention for the Protection of Performers, Producers of Phonograms and Broadcasting Organizations, and the WIPO Copyright Treaty.

The copyright held by an author curtail to two types: economic and moral rights. Economic rights allow the owner of the copyright to derive financial reward from the use of his works by others. For instance, if someone writes a book, and another person copies the book and sells it, the copyright holder can claim that income. Moral rights protect the non-economic interests of the author. For instance, if changes made to any work of which the maker of those changes does not hold the copyright, and by doing so damages the reputation of the original author and copyright holder, the author has grounds to stop that adaptation, even if the one changing the work does not stand to gain anything from the changes.

2.1.2.2 Trademarks

A trademark is a sign or combination of signs used to distinguish the goods or services of one enterprise from another (WTO, 2018). The purpose of trademark protection is to ensure that brand value established by a company cannot be 'stolen' by another company by adopting the same (or very similar) sign in the sale of a similar product.

Trademarks must be registered through an application for trademark protection. Regional or national trademark offices deal with the applications of the trademark applications. These offices determine whether the trademark does not already exist and whether the rights about to be granted are not the same or similar to trademarks already owned by the applicant or by third parties who hold similar rights. Once granted, *"the owner of a registered trademark shall have the exclusive right to prevent all third parties not having the owner's consent from using in the course of trade identical or similar signs for goods or services which are identical or similar to those in respect of which the trademark is registered where such use would result in a likelihood of confusion"* (TRIPS, 2018).

The period of protection of a trademark is indefinitely, as long as the fees for registration are being upheld by the proprietor and the trademark is being used. The effects of a granted trademark are dependent on the country in which this protection is provided. To circumvent applications in each separate office around the world, WIPO has an international registration system for trademarks. These international registrations for WIPO applications are handled through national offices.

2.1.2.3 Industrial Designs

The Industrial Design rights refer to the protection of ornamental or aesthetic aspects of an article. An important part of the industrial design rights is that it cannot constitute an inventive or technical feature. In other words, the claims of industrial design cannot contribute to the functionalities of the subject-matter. This, along with the limitation on patent protection theoretically eliminates overlap in the

two protection mechanisms. The industrial designs aim to protect that aspects of an entity that makes it appealing, which contributes to the commercial value of a product. An industrial design right need not be invented before protection on the aesthetic value of the product is possible. This means the functionality of the subject-matter does not necessarily have to be physically possible with current technology. Futuristic designs are eligible for protection as well, i.e. a very aesthetically appealing teleporting machine.

Applications for registration of industrial designs are necessary in most countries. The definitions of the requirements of industrial designs and the subsequent registration process differ per country. Generally, the design must be new or original. However, the definition of new is subjective, especially with design. The period of protection is generally five years, with possibilities of extension to a period of fifteen years. The way in which countries deal with industrial designs varies to a large extent.

2.1.2.4 Geographical Indications

You have likely heard of Champagne only being called Champagne if and only if it originated from the correct region. This is why you cannot officially call Prosecco by the name of Champagne, even if the quality is much higher. The fundament of Geographical Indication is the reputation or quality of a product from a certain region. Other examples of geographical indications are Irish Whiskey, Roquefort, Parmigiano Reggiano, and as it turns out, Prosecco. You might not be allowed to call Prosecco Champagne but someone referring to Champagne as Prosecco is also in violation of a geographical indication.

These rights exclude the use of the value associated with the region in a misleading way. It stops people from freeriding on the perceived quality of the regional products. Even though the most geographical indications are concerned with consumer products, often food and beverages, the law does not necessarily limit itself to this field. Geographical indications could also protect products that are manufactured in a specific geographic region and are created due to human factors exclusive to that area. An example of this is Switzerland, who are associated with the manufacture of excellent watches. Swiss-made is a term protected by geographical indication because the added value of this term is big enough to potentially harm the Swiss. Apart from protecting the manufacturing parties from wrongful use of their exemplary reputation, geographical indications also aim to protect the consumer who would be misled by wrongful use of the indications. Questions regarding the use of geographical indications are often very complex as they are, as are many fields in law, very subjective. The reader is invited to consider the development of Champagne-ice, wherein 12% of the volume is real Champagne. Is the creator of the ice cream allowed to use the word Champagne in the marketing of his product? Not according to the European Court of Justice in a non-binding decision, as it turns out (Heathcote, 2017), while not all national courts share this view and provide a far more distributed judgement (Jay & Taylor, 2013).

2.1.2.5 Patents

A patent is an exclusive right for the commercialization of an invention. In its simplest form, a patent makes sure an inventor is protected from infringement after he produced something new, his invention. The notion of an invention must be defined but is not done so historically (Jewkes, 1958). The notion of an invention must of course be defined and is done so, marginally, in the conventions of regions later to be discussed. As an example, the European Patent Convention (EPC) states that a patent shall be granted for any invention, in all fields of technology, provided that they are new, involve an inventive step and are susceptible of industrial application (EPOrg, 2000). It then goes on explaining what will not be considered as an invention and does not provide the reader with a definition of the concept. It is generally understood that the invention to be patented constitutes a technical solution to a technical problem. Following WIPO, it must show an element of novelty, an inventive step and must be accepted under regional or national law as patentable. These elements of novelty and inventive step are, because they are stipulated by WIPO, recurring in national patent law around the world and therefore important to fully understand. Novelty entails that the patented subject-matter must not exist in the *state of the art*, or the current state of the technology. Fundamentally, to qualify as patentable subject-matter, the invention must be new, i.e. not

published in any way. In addition to this, the inventive step states that the subject-matter must also involve a degree of inventiveness, also coined as non-obviousness. A novel solution to a problem is not patentable if a *person skilled in the art* of that problem would easily solve it with this solution. Finally, as was stated in the definition of intellectual property right, many national patent laws state that an invention must also have a degree of industrial or commercial applicability. Which means that a novel and inventive solution to a problem cannot be patented if it makes no sense to solve that problem. In other words, there must be a good reason why the problem that is solved is actually a problem.

Important to note is that a patent is not an automatic right (as is copyright) and has to be applied for, which is called 'filing a patent application'. Upon filing the application, a patent office, either regional or national, will investigate the patent applications and refuse or grant the patent application. They generally do so in two steps, the search report, and the examination. In the search report, the claims in the patent application are compared to prior art and the patent office shares with the proprietor, all prior art that was found and proves relevant for the patentability of the invention. The examination is the process in which the patent office examiners determine whether the subject-matter is eligible for patent protection considering the country- or region-specific law and the contents of the search report. In the examination procedure, the examining division can grant the patent or issue a search opinion, communicating limiting factors on the patentability of the subject-matter of the application and requesting a reply from the applicant. After the response, application is examined again, after which the examining division can propose the grant or refuse the application. The application can be refused if the earlier objections are still present or if the changes made to rectify them are not in line with the law. Upon refusal, the applicant can still decide to fight the decision in appeal. The institutions that play a role in this process will be discussed below.

Another important aspect of the filing procedure in patent law is the priority date. The priority date is the first day of filing of the first application of an invention. The right to priority allows applications filed in WTO member states or contracting states of the Paris Convention to file additional patent applications within twelve months of the original filing, using the state of prior art at the priority date. Following Art. 87 EPC: *"Any person who has duly filed… …an application for a patent, a utility model or a utility certificate, or his successor in title, shall enjoy, for the purpose of filing a European patent application in respect of the same invention, a right of priority during a period of twelve months form the date of filing of the first application."* (EPC, Priority Right - The European Patent Application, 2000), which means that for determining novelty, based on prior art, the priority date will be used, rather than a later application date for the same invention. In practice, this translates to the possibility of publishing (and as such creating prior art) your invention after filing for patent protection in one country, and still being able to qualify for patent protection in all other countries. This allows a company to market their invention, without the idea being stolen in other countries as a result of their publication while still holding the possibility of filing for other patents in that year. The benefit of this right is that it is not necessary to file in all countries at once, which allows the applicant to spread the costs of patent protection.

2.1.3 Property

The definition of property, as commonly used in intellectual property law, is not defined by law. It should be defined per the interpretation of the common denominators within the law. Intellectual property, per the law should provide an *exclusive* right, should be *transferrable* and countries that partake in the World Trade Organization should *recognise* the intellectual property laws, and by extension the rights of other countries and its inhabitants. As such, property as used in intellectual property law can be described by using the combination of the definitions of Penner and Hegel, as proposed by Ishmaev in his 2017 paper on the possibility of Blockchain as an institution of property (Ishmaev, 2017). It rests on the fundaments of three concepts; exclusivity and separability (Penner, 1997) and recognition (Hegel, 1991), which coincide with the notions of the law. The property of an entity, once possessed, should transfer to the owner, the possibility to exclude other from using the property, to separate the rights from ownership from the owner (right should be transferrable) and recognition of ownership by others.

2.1.3.1 Data Ownership

In addition to the definition of property as often used in intellectual property law, it is also interesting to shed some light on the concept of ownership with respect to data, as data plays an increasingly big role in companies (Levitin & Redman, 1998). Especially in a network, and specifically on a decentralized network, such as a Blockchain network, the concept of ownership is fuzzy at best. To provide a brief introduction to the concept of data ownership, consider the situation wherein you are using a Blockchain-based application for which you produce data, which is then dispersed in the network, but which is data that also hold a connection to a measurable asset. For example, if you share solar energy in a local Blockchain-based grid – which is an excellent application of the technology – you produce information about the energy produce in the form of data, which holds aspects that relate to time, location, prices and volume of the energy in the network. The information then exhibits both characteristics of data production that represents an asset (such as energy) and intangible data such as time and location characteristics of the production of the energy. Now, the question is, what do you own? And if not you, does anyone actually own data?

We first consider actual data, not the asset that is represented by the data. The information that is produced by sensors in your solar panel or information that you enter into the system manually, such as personal details, is uploaded into a system with no server, which means the location of the data is dispersed. Furthermore, the data is copied and distributed every time a transaction occurs on the network, generally speaking. In summary, there is no original data but rather multiple copies that are distributed and intertwined with changing other data. If this were to happen to a conventional piece of property, it would hardly be considered property anymore. Imagine this would happen to a book. You write something in a book about yourself, that book is then copied and distributed amongst a number of people. They all rewrite the book, not necessarily changing what you wrote but adding to it and changing the structure of the book. Every time someone adds something, the book is copied and distributed to everyone again. Is the information you wrote in the book yours? To circumvent this issue, we can identify ‘data authors’, as was done by Wallis and Borgman in their 2011 paper on data authorship and ownership (Wallis & Borgman, 2011). Here, they advocate the importance of allocation of ownership of data based on who created the data, wherein reference is made to the description of authorship by Foucault, which was based on general labour theory as proposed by John Locke, wherein is conveyed that appropriation of an entity is subject to the work that is being done to create said entity (Locke, 1690). This is what eventually resulted in the ‘sweat of the brow’ doctrine, the foundation of intellectual property law, in particular copyright. Following the analysis by Foucault and earlier scholars, an author is a person who attributes to the creation of a work. He then goes on to explain that the creation of authored work is not a simple and uniform process and might involve multiple actors without a distinct barrier between the written work (Foucault, 1977). Subsequent to this argumentation, Foucault argues that the name that is given to an author is linked to the authored

work, rather than the actor who performed the work. This gives the possibility of group authorship where the created work in collaboration with other actors is a bigger sum than its parts in terms of utility.

While the concept of group authorship is very applicable to the concept of Blockchain technology, the use of such a method for determining the ownership of data can limit the attribution of data to a specific owner. The concept of authorship to define ownership however, specifically to circumvent the problems of group ownership of data, is very useful. Specifically, this would allow pieces of data to be attributed to specific users. Even in case of changes to the data, the addition or adaptation to the data can be attributed to specific authors, thereby identifying exactly what was done to the data and by whom. This reduces the problem of data property to a trade-off between the amount of work it takes to keep track of these changes and the added benefit of data property over this amount of work. Thereby at least structuring the problem very clearly; if there is no record of ownership of the data in a network, the author will be considered not to have vested interests in the ownership of said data. There remains one problem, namely that of who the author is. Imagine you use a sensor that is produced by a company, who have a method claim for producing data in their patent (for explanation see section 4.3.3), then who is the owner of the produced data (see figure 6)?

In addition to the above, a different side of data may be considered, the case in which the data is not relevant but rather the asset is represents (energy, money, storage, CPU, etc.). If the data on a Blockchain network represents the property over which legal allocation is disputed, the question becomes whether decentralized data on a Blockchain network can actually entail property allocation from a legal perspective. Now, while this is an extremely interesting and difficult question, it is not entirely relevant as this research concerns itself with the intellectual property of the technology, not the assets it represents. In infringement cases, the question to whom produced data belongs is relevant, the question what that data represents is very interesting, but not relevant to the objective of this research.

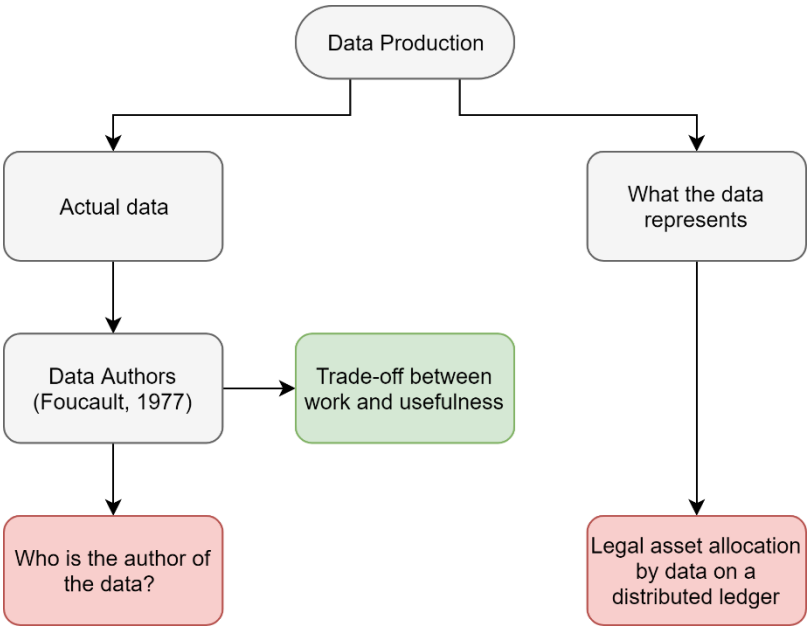

Figure 6 - Problems in Data Ownership

Finally, in addition to the above, the positioning of regulation (also see section 1.2.2.1), or rather the lack thereof, in the field of data production is important to consider. The lack of structured and transparent regulation makes answers to the above questions (figure 6) non-uniform over and within jurisdictions (Kostkova, et al., 2016).

2.1.4 Relationship between Intellectual Property Rights and Innovation

The discussion about the validity of the intellectual property system as an accelerator for innovation, as it was originally meant, is still ongoing. It is a topic of great interest, also with regard to this research. Bessen and Maskin (2009) argue that innovation is being hampered in today's dynamic model. The idea of intellectual property law, according to them is perfectly capable of accelerating innovation in a 'static' world, in which imitation of innovative activities hamper incentives to invest. However, in a 'dynamic' world, that incentive seems to still be there without protection of intellectual property rights (Bessen & Maskin, 2009). What the writers define under a 'dynamic' world is the existence of sequential innovation, meaning that inventions tend to build on one another. In this case, they argue, patents could hamper innovative activity as the fundaments are protected by a patent. However, it is obvious from the way in which the inventive step procedure has been formulated that a step on the existing state of technology is regarded as patentable material. The point by Bessen and Maskin would only hold if the law has not been applied properly. Generally, the literature surrounding the topic have excellent points of consideration and utter disregard for practicalities.

Proponents of intellectual property law and its implications on the acceleration of innovation often argue that companies need to be incentivised to innovate and that intellectual capital provides a measure for the valuation of companies. From a macro-economic perspective, there is evidence to suggest that the level of competition in an open market is a driver for the level for innovation incentives. This relationship is then positively influenced due to the existence of a patenting system (Aghion, Howitt, & Prantl, 2013). Opponents of the same topic argue that large corporations are stifling economic growth and innovativeness by hoarding intellectual property rights so as to create a barrier for any inventor not affiliated with large companies. Also, they often produce arguments pointing towards the high degree of innovation in the software industry as proof of their consideration of the limiting nature of intellectual property rights. However, while both sides might be right, the system cannot just be abolished, it would be practically impossible. The economic system relies too heavily on the valuation of intellectual property rights and as such, the abolishment of intellectual property law would likely lead to a large shift in global power (Evans & Layne-Farrar, 2004). Furthermore, the limiting nature of the patent system is often acclaimed to the fundamental territoriality of the system. This territorial inclination is problematic as it puts the relationship between emerging technology and intellectual property further under pressure with an increase in globalization which leads to high economic interdependence and inflated costs of intellectual property right protection of multiple nations (Chisum, 1997). Taking the above into account, the flexibility of the law to cope with the increasing pressure on the relationship between intellectual property law and emerging technology is an imperative task for continued innovation incentives.

2.1.5 Important Institutions for Intellectual Property Law

Now that we have established the most important types of intellectual property rights, the regulatory system surrounding those rights can be discussed. For the purpose of this research only the most important institutions will be discussed, starting from a global perspective, going to regional offices and to national regulatory bodies. To determine what regulatory bodies to incorporate in this section, in particular regional and national bodies, we look at their activity in the field of patent protection with regard to Blockchain technology. The measure of using patent analysis is taken because other types of law are either not suitable for Blockchain technology or not filed clearly, leaving no data to examine. For example, copyright is given to every creator literary and artistic work without registration, and as a result, it would be very difficult to draw any valid conclusions as to what the biggest proprietors of intellectual property protection are from the (non-existent) data.

As not every patent office, at a regional or national level will prove to be relevant, the patents and patent applications containing the word Blockchain in title, abstract or claims from 2006 onwards are considered. Patents can be grouped in so-called families, clusters of patents sharing priority dates. As an example, if a patent application is filed in the Netherlands, the proprietor then has one year (the priority year) to file additional patent applications in other regions, using the priority date of the first applications. Let's say the proprietor then files in France and Germany, using the priority date of the first application. These three patent applications are now all clustered in one family because they rely on the same priority number. Of course, this means that the claims of the later patent applications, with respect to content for which priority is claimed, are not broader than the first patent. Following Art. 88 (4) EPC, elements for which priority is claimed, that do not appear in the original application may only be granted if the original application specifically disclosed these elements (see Appendix C). So, family clusters should cover the same subject-matter as the document on which their priority is based.

The below figure shows the jurisdictions of granted patents, the majority is in the United States, followed by China and South Korea. In the application procedure, we see the majority of applications in the United States, followed by the PCT procedure, China and Australia (figure 7). Noteworthy is the discrepancy between filing at the European Patent Office and the grants resulting from those applications. Also, South Korea is of note, as its success rate seems relatively high as compared to other countries (also see section 6.1.1). Australia will be excluded from the analysis, as will be stated in the following section, because the main proprietor of Blockchain patents in Australia is Causam Enterprises Inc. which is a renowned patent collector, not specifically for productive use. Also, the granting procedure for patents in Australia is much less extensive to other countries, making it ideal for easy patents. Finally, the Australian Criag Wright, the self-proclaimed inventor of Bitcoin, has currently 56 running applications through a shell corporation called EITC Holdings Ltd, which holds no granted patents (see Appendix E). These factors taken together have led us to consider only USPTO, SIPO, EPO and KIPO (see below).

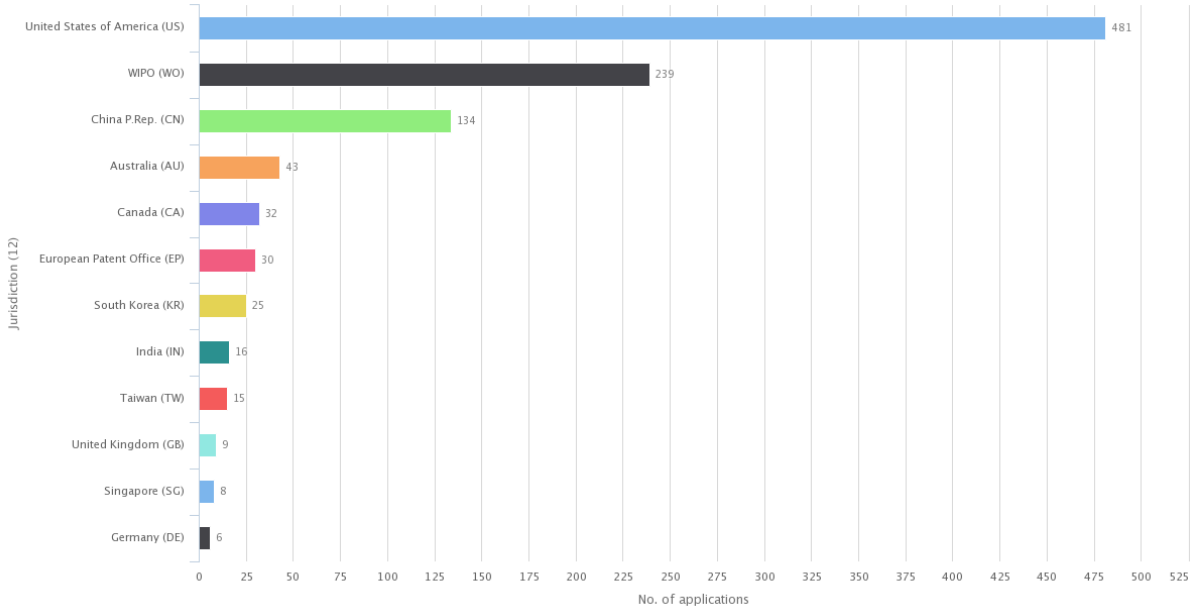

Figure 7 - Applications for Blockchain Patents (Source: PatBase)

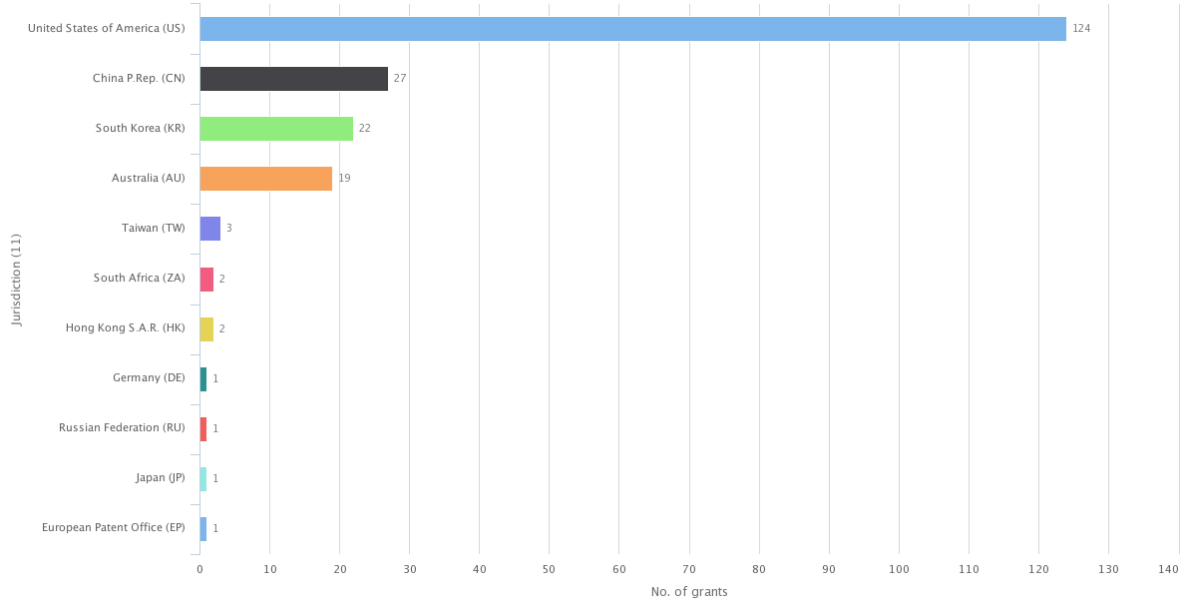

Figure 8 - Granted Blockchain Patents (Source: PatBase)

We will start with the two most important global institutions, the beforementioned WIPO and the World Trade Organization. Next, the biggest patent offices will be discussed, first on a regional level, then on a national level. The European Patent Office is a regional patent office, it covers filing procedures for the member states of the European Patent Organization. Other examples of regional offices are the Eurasian Patent Organization (EAPO) and the African Regional Intellectual Property Organization (ARIPO). For the purposes of this research, we will only consider the European Patent office on a regional level. The ARIPO and the EAPO are not relevant as they do not cover countries in which the patenting activity of Blockchain technology applications is high. On a national level the United States Patent and Trademark Organization, the State Intellectual Property Office of the People's Republic of China and the Korean Intellectual Property Office will be covered separately and as part of the national system that falls under the jurisdiction of the EPO, the Dutch Patent Office, the Intellectual Property Office of the United Kingdom and the German Patent Office will be analysed, mainly because these are likely to form the foundation for

the Unified Patent Court in Europe and are leading patent offices in Europe. China has been included because of the huge increase in patent filings as a result of their economic growth (Cookson, 2018). In addition to this, the Unified Patent Court, which does not exist yet, will be explained.

What will also be discussed are the various possible filing procedures in the relevant regions, namely national filing, regional filing and PCT filing, as part of WIPO. The national filing method is handled through the national patent office and is subject to country-specific law. The regional filing procedure works roughly the same albeit that the filing follows procedures set by international treaties and (until the implementation of the Unified Patent Court) for the fact that grants need to be requested in individual countries after a regional grant has been admitted. Finally, the Patent Cooperation Treaty (PCT) is a global filing route following a treaty administered by WIPO and will be explained in the discussion about WIPO and its most important treaties.

2.1.5.1 World Intellectual Property Organization

The World Intellectual Property Organization is one of the agencies of the United Nations and currently has 191 member-states. It has been established in 1967 with the purpose of developing a balanced and effective international intellectual property system. WIPO has bundled the most important treaties to create a body of 26 treaties. These treaties are the foundation of modern intellectual property law and provide a basic view of how intellectual property law works around the world. Following the Convention Establishing the World Intellectual Property Organization, which has been administered in 1967, the role of WIPO is *"to promote the protection of intellectual property worldwide; and to ensure administrative cooperation among the intellectual property unions established by the treaties that WIPO administers"* (WIPO, 1979). Without going in too much detail, additional notable treaties administered by WIPO are the Berne Convention, the Madrid Agreement, the Paris Convention, the Trademark Law Treaty, the WIPO Copyright Act and the Patent Cooperation Treaty.

The Berne Convention was administered in 1886 and provides to WIPO the fundaments of copyright law. The Berne Convention stipulates the minimum amount of protection necessarily granted by copyright law to the author of literary or artistic work. It not only forms the basis of copyright law for the countries administered to the United Nations but also to the countries that are a member of the World Trade Organization as their 'rules on membership', which will be later defined, include the Berne Convention as a requirement for membership. The three fundamental principles as defined in the convention state that the rights must be equal across all member states, the right must be automatic, and the protection must be independent of the country in which the work originates. Furthermore, the various rights are stipulated in the convention (e.g. the right to broadcast, the right to translate, the right to recite, etc.) and duration of protection is stated to be no less than fifty years after the death of the author.

The Madrid Agreement concerns itself with the right to geographical indication. It states that all goods that display false indication of source, must be seized upon entry into the contracting states. The agreement has been signed in 1891 and was revised at the latest in Stockholm in 1967. The courts of individual member states of WIPO must act according to their own law, but the agreement stipulates only the generic scope of protection.

The Paris Convention is the oldest treaty administered to WIPO. It was signed in 1883 by only eleven countries and has since proven to be the foundation of modern intellectual property law. It applies to patents, trademarks, industrial designs, utility models, service marks, trade names, geographical indications and the repression of unfair competition (WIPO, 1883). It states the level of protection of intellectual property under the law as a result of bestowing certain intellectual property rights to a person or an entity. It states that national treatment of these rights must convey protection across all member states in a comparable way so as to exclude arbitrage possibilities of discrepancies in the law. Another important aspect of the Paris Convention is the inclusion of the right of priority. The right of priority provides the ability of a right holder to file for protection in other countries as well, in a given time period.

The application used the priority date of the beforementioned application which results in a time gap of prior art. The examiners will use the state of the art at the priority date to determine the validity of the application for a certain right. Finally, the convention articulates certain rules about the way in which contracting states must handle distinct types of intellectual property law in order to unify the field of intellectual property law, albeit to a limited extent.

The Trademark Law Treaty states aims to standardize the procedures of trademark registration across the member states. The treaty has been signed in 1997 and provides a harmonization and simplification framework for the three phases of procedures before a trademark office: application for registration; changes after registration; and renewal.

The WIPO Copyright Treaty (WCT) does not encompass a comparable size of field as other treaties administered to WIPO. Just like the Berne Convention, the WIPO Copyright Treaty deals with copyright but constitutes a special agreement that falls under the Berne Convention, for which a separate convention was constructed. It concerns the protection of works and the rights of their authors in the digital environment (WIPO, WIPO Copyright Treaty (WCT), 2018). The subject-matters to be protected by copyright according to the WCT are computer programs and compilations of data. Imaginable, this act might be relevant to further examinations of the protection strategy of Blockchain technology applications, if copyright is indeed applicable to the appropriation of intellectual property rights for Blockchain technology applications.

Finally, the Patent Cooperation Treaty (PCT) provides an international filing procedure for patent applications. The treaty was signed in 1970 by thirteen contracting states and was established in 1978. Currently, there are 152 contracting states under the Patent Cooperation Treaty. After filing a national application, (from the priority date) the applicant has one year to perform additional filings to obtain protection in other countries. If the applicant files an international application through the PCT procedure at a national or regional patent office or directly with the international bureau, the application will be examined by the International Search Authority (ISA), which can be followed by a preliminary examination by the International Preliminary Examining Authority (IPEA) after publication. These authorities are national or regional offices, appointed by the World Intellectual Property Organization (22 of them), and include the EPO, USPTO, SIPO and JPO. Eighteen months after the priority date (of first national filing), the application as filed with the respective office as part of a PCT procedure is published. After 30 months, the application, along with its search reports, is ready to enter national phase, where the search report of the international filing is used to grant patents on a national or regional level. The result of the examination through the PCT procedure is a non-binding opinion, meaning that national or regional offices perform their own search and examination, taking into account what was established by the International Search Authority. This could, but does not necessarily, lead to a granted patent on a national level, depending on the quality of the search and examination, accompanied by the bilateral agreements between offices. National offices that handle applications through a PCT procedure generally perform their own search and examination but the preliminary findings of the PCT procedure often prove a more solid foundation for a granted patent than a direct national filing. This generally reduces the amount of correspondence and appeal cases associated with patent prosecution on a national level and as such, reduces costs. Also, the added benefit of only having to file on a national level after thirty months is important as it allows new inventions to be published to attract funds over a longer period since the priority date.

2.1.5.2 World Trade Organization

In 1995, the International Trade Organization was replaced by the World Trade Organization due to the Marrakesh Agreement. The WTO is the only body that regulates international trade. It does so by administering rules through agreements as a result of meetings by participatory nations. Almost all nations in the world are members of the WTO, exceptions are the observing nations, to whom access to negotiations is granted per exclusion of active voting rights, and non-members, such as North-Korea and

Greenland. At the centre of the WTO stands GATT (General Agreement on Tariffs and Trade). For intellectual property law, the main focus of GATT is TRIPS, the Agreement on Trade-Related Aspects of Intellectual Property Rights. This agreement indicates the minimum level of intellectual property rights protection to which national law of member states must comply. In this agreement, the aforementioned rights and others that have not been detailed are conferred. The agreement specifies for these rights, procedures of enforcement, remedies and dispute resolution procedures. Because practically all relevant countries are member-states of the WTO, TRIPS functions as a basis principle of intellectual property law and can be seen as levels of law which all countries that might be dealt with in this research comply with.

2.1.5.3 United States Patent and Trademark Office

In the United States, the USPTO (United States Patent and Trademark Office) is the national patent office. Established in 1975, USPTO is an agency in the United States Department of Commerce. It deals with Patent Applications and Trademark registration and acts in accordance with the constitution of the United States. The United States Code, Title 35 concerns itself with Patents, trademarks, and Industrial Designs (USPTO, 2003). It also includes the Patent Cooperation Treaty and filing and protection procedures in the United States.

2.1.5.4 Korean Intellectual Property Office

The KIPO (Korean Intellectual Property Office) is the national patent office of South Korea. It has been established in 1949 as an external office of the Ministry of Commerce and Industry and joined the World Intellectual Property Organization in 1967. In 1980, KIPO signed the Paris Convention, and shortly after the Patent Cooperation Treaty. It operates under the Patent Act of the Republic of Korea, which was administered in 1961 and covers dispute resolution over competition, enforcement of Intellectual Property, regulatory bodies and utility models.

2.1.5.5 European Patent Office

The EPO (European Patent Office) is the executive body of the European Patent Organization (EPOrg), which also governs the Administrative Council. The European Patent Office was formed in 1977 in Munich and follows the European Patent Convention (EPC). The EPC provides the regulatory structure to the European Patent Office was constructed following the national procedures of the major contracting states of the European Patent Organization. The Administrative Council of the European Patent Organization is tasked with overseeing the work of the European Patent Office. It can also amend the rules of the EPC and even some provisions of the articles of the EPC.

2.1.5.6 State Intellectual Property Office

In China, the Patent office is the State Intellectual Property Office (SIPO), which was founded in 1980 with their introduction to the World Intellectual Property Organization. SIPO follows three main laws regarding intellectual property: Patent Law of the People's Republic of China; Copyright Law of the People's Republic of China; and Trademark Law of the People's Republic of China (SIPO, Laws, 2018). These are based on the Berne Convention for the Protection of Literary and Artistic Work, under WIPO and the Agreement on Trade-Related Aspects of Intellectual Property Rights under the World Trade Organization.

2.1.5.7 Dutch Patent Office

The DPO, Dutch Patent Office, is a department of the Dutch Enterprise Agency, which falls under the ministry of economic affairs. Founded in 1893, the Dutch Patent Office is one of the earlier adopters of patent law. The Paris Convention provided the first basis for the national patent law. This national law is the Dutch Patent Act (Rijks Octrooi Wet, ROW). A remarkable feature of the Dutch Patent Office is their examination method, or rather, lack thereof. When filing a Dutch patent application, the Dutch Patent Office performs a search of prior art but does not examine the patent application on validity. As such, the granting rate of patents in the Netherlands is very high.

2.1.5.8 Intellectual Property Office

In the United Kingdom, the Intellectual Property Office (IPO) provides the national services of intellectual property law. Established in 1852 through the Patents Law Amendment act, the IPO follows The Patents Act; the Trade Marks Act; the Copyright, Designs and Patents Act; and the Registered Designs Act.

2.1.5.9 German Patent and Trade Mark Office

The DPMA (Deutsche Patent- und Merkenamt) is the German national patent office, headquartered in Munich. It is the largest national patent office in Europe and has been founded in 1877 as part of the Federal Ministry of Justice and Consumer Protection. It follows the German Patent Act, and the European Patent Convention.

2.1.5.10 Unified Patent Court

As previously mentioned, the Unified Patent Court (UPC) is an entity that does not exist yet. The foundation of the UPC is the European Union and the UPC aims to grant unitary European patens, as a result of the grant of certain granted European patents in accordance with the EPC. In addition to this, the court will rule on validity and infringement litigation and establish harmonized case law. It will be established through the Agreement on a Unified Patent Court, which so far has been signed by all member states of the European Union, except for Spain, Croatia and Poland.

Currently, a granted patent from the EPO, following procedure based on the EPC, results in a bundle of patents on a national level. Generally, the national offices review the search report and the examination performed by the EPO briefly as their granted application does not constitute any serious grounds for doubt about the validity of a patent. It might be argued that the need for unity in the world of patent protection stems from the developments of technology (Pilch & Shalloe, 2005). These have led to globalization and complexity of data in patent applications. The globalization affects patent applications and the way in which they are being handled in such a way that national patent protection is hardly ever enough. The complexity of data on the other hand leads to an increased volatility in the way in which they are handled by separate entities. What results is a situation where almost entirely global patent protection is needed while the application and involved procedure of such protection varies over regions. The Unified Patent Court aims to partly rectify this.

However, the UPC also exemplifies the aforementioned rigidity of intellectual property law. While this change of the field of intellectual property law is quite remarkable, the procedure is taking a very, very long time. Recent affairs in both Britain (Brexit) and Germany have delayed progress even further, while the development of the UPC has been a topic of consideration for years. The most fundamental change that aims to rectify recent shortcomings of the field is taking too long to keep up with the flexibility of what the field aims to protect and shows the gap between technology and law that this research aims to address.

2.2 Blockchain

The second section of the literature review will explain the concept op Blockchain technology. First the literature sources will be provided, after which the technology will be explained per the technological methods of various consensus mechanisms.

2.2.1 Literature Sources for Blockchain

This section will discuss the literature sources that provide a base understanding of the working principles of Blockchain technology. As the subject of Blockchain technology is relatively new, the sources of the fundamental papers about the technology, the specific whitepapers, are not published in scientific journals, see table 3.

Table 3 - Literature for Blockchain

Author(s)	Year	Title	Journal	Subject
Castro & Liskov	1999	Practical Byzantine Fault Tolerance	*Laboratory for Computer Science, MIT*	The first solution to the Byzantine Generals Problem
Chepurnoy	2016	Interactive Proof-of-Stake	*ArXiv e-prints*	Nothing-at-Stake attacks on PoS systems
Kiayias et al.	2017	Ouroboros: A provably secure proof-of-stake blockchain protocol	*Annual International Cryptology Conference*	Proof-of-Stake methodology
Lamport, Shostak & Pease	1982	The Byzantine Generals Problem	*ACM Transactions on Programming Languages and Systems (TOPLAS)*	Byzantine Generals Problem, introduction into problem that Blockchain solves
Laurie & Clayton	2004	Proof-of-work proves not to work	*Workshop on Economics and Information, Security*	Proof-of-Work and power usage
Mazières	2015	The Stellar Consensus Protocol: A Federated Model for Internet-Level Consensus	*N/A*	A practical adoption of the Practical Byzantine Fault Tolerance in a Blockchain Application
Nakamoto	2008	Bitcoin: A Peer-to-Peer Electronic Cash System	*N/A*	Bitcoin and Blockchain fundamentals
Pilkington	2016	Blockchain Technology: Principles and Applications	*Research Handbook on Digital Transformations*	Blockchain principles
Popov	2017	The Tangle	*N/A*	A description of the working principles of a Directed Acyclic Graph
Tapscott & Tapscott	2016	Blockchain Revolution - How the Technology behind Bitcoin is Changing Money, Business and the World	*N/A (Book)*	Basic introduction into Blockchain technology
Zheng, Xie & Dai	2017	Blockchain Challenges and Opportunities: A Survey	*International Journal of Web and Grid Services*	Description of different consensus mechanisms and their applications

For a general overview of Blockchain technology applications and use cases, the 2016 book by Don and Alex Tapscott, *Blockchain Revolution – How the Technology Behind Bitcoin Is Changing Money, Business and the World* is used (Tapscott & Tapscott, 2016). This book is considered as an excellent first overview of Blockchain work cases and includes a detailed explanation of the working principles. It is the go-to book for an introduction to Blockchain. It reveals the ability of the technology to surpass the financial sector and its merit for adoption into many other industries. It also provides a forward look as the writers explore possible use cases (both realistic and unrealistic) for the future. Because the contents of the book, arguably, would not live up to the academic standards that other literature sources mentioned in this research do, the book provides an easy introduction for people with little knowledge in the field of Blockchain.

Second, Marc Pilkington wrote a paper about the core concepts, definitions, risks and applications of Blockchain technology. He argues that the Blockchain technology is fundamentally a system of decentralized trust and highlights the disruptive nature of the technology with as a result the widespread adoption that we are indeed seeing in many industries (Pilkington, 2016). Whether the predictions of Pilkington will prove realistic is yet to be seen. However, we can say that the wide array of possibilities that these predictions show, is a good indicator of why the technology has gained the high degree of traction and popularity that it did. Furthermore, Pilkington highlights exactly what the benefit of the transactional system is; decentralized trust. The only use cases where the adoption of Blockchain technology is useful, is where there is a problem that can be solved through decentralized trust.

In addition to the above, the original Blockchain whitepaper, Bitcoin by Satoshi Nakamoto will be discussed (Nakamoto, 2008), with the addition of the Tangle, by Serguei Popov (Popov, 2017). The paper by Nakamoto functions as a base explanation of the principle of the consensus mechanism underlying Blockchain technology and the paper by Popov is discussed so as to provide an example of an adaptation to the system that might constitute an invention. Also, the 2015 paper by Mazières will be discussed, in which he incorporates a distinctive solution in a Blockchain application as part of Stellar, the financial network that uses 'Lumens' as electronic cash (Mazières, 2015).

2.2.2 Overview of Blockchain Technology

This section will provide an overview of the Blockchain technology. First, key concepts that are fundamental to the technology will be discussed. It is important to understand the in-depth fundaments of the technology to some degree to make any conclusions about the technology from an intellectual property perspective. This will be done by describing what events take place in a Blockchain during transactions. Because of the large complexity of the technology, the first Blockchain system is explained first, Satoshi Nakamoto's Bitcoin Blockchain. After the working principles of this technology are clear, variations to the technology will be described.

2.2.2.1 Bitcoin

In the earlier definition of Blockchain, the system was described as a distributed list of records, in which transactions are signed using public-key cryptography. While this is an accurate description of the general principle of the system, it does not explain how it actually works. To provide a full explanation of the way Blockchain technology works, the Bitcoin Whitepaper will be briefly discussed (Nakamoto, 2008).

As described by Satoshi Nakamoto, the Bitcoin Blockchain technology aimed to provide a solution for the 'double spending problem' (see List of Definitions). This problem arises from the functionalities of peer-to-peer transactions where it would be possible to just create copies of your digital money. In a traditional banking system, physical money cannot easily be copied, and the digital money is closely monitored by the banks, who hold a ledger that tracks all transactions, which stops double spending. If the trusted third party, traditionally a bank, is gone, the payment system must be based on cryptographic proof, rather than trust, argues Nakamoto. In the Bitcoin Blockchain, he proposes a solution to the problem by distributing the ledger of transactions and its calculations over a network of participants that work together to generate computational proof of the activities that need to be verified in the network.

So, how does the system make these transactions secure? The transactions that take place between peers make use of a public key and a private key. The public key is a string of digits that a node (a point, usually a user, in a network, see List of Definitions) holds, which is meant to identify users to which transactional content much be sent. The private key is used to sign the transaction from the node creating the transaction, which creates a signature. A public key and a private key are linked, which means a second node receiving the transaction, can use the public key and the transaction signature to verify that the transaction was authorized by the person holding the private key. This method ensures only the holder of a private key can create transactions from the account linked to that private key. To ensure there is anonymity in the Blockchain during a transaction, the private key must be kept secret, which is done through the use of a hash function. The transactional data from the previous block, along with the public key of the recipient are passed through what is called the hash function, to create the signature of the transaction. This signature then will be signed by the private key of the sender to proof that the transaction-content comes from the acclaimed source.

A hash function is a one-way computational gate. The input of a hash function is any combination of data and the output is a string of digits of a predetermined length. From the hash-output, the input cannot be derived. The hash function that is used in the Bitcoin Blockchain is the SHA-256 (Secure Hash Algorithm), which has been developed by the National Security Agency (NSA) in the United States. Without going into detail about the working principles of the code in a hash function, the important characteristic of a hash-function is the fact that any specific data will repeatedly produce the same hash output while it is near impossible to reverse engineer the hash function to determine what the original string was. This output, the signature of the transaction can therefore be verified with the public key of the sender.

To verify the transaction, the Blocks in the chain receive a nonce, which is an input to the hash function of the transaction. This nonce needs to be a specific number to match the hash output to the required output, which is any hash starting with four zeros. The calculation of what this nonce value must be, is what is called mining. This is what ensures the validity of a string of transactions. If a transaction in the middle of a chain is altered and mined, so as to receive a correct hash, that will match the input of the next transaction, the hash in the following transaction now no longer has the requirement of the set number of zero bits in the first values of the hash. This means that the next block needs to be mined as well, and the next block, and the next block, providing for quite a lot of CPU effort (Laurie & Clayton, 2004). This work is what the terminology of Proof-of-Work (PoW) is based on.

However, this still does not make the Blockchain secure. After all, it might take some time and effort, but altering a transaction clearly is possible. This is where distribution comes in. If the Blockchain as described above is distributed amongst a number of nodes in a network, the nodes can compare the data of Blockchains to one another. If for example, the wrong Blockchain, altered by a node that tries to double-spent transaction-content, is completely validated because the double spender mined all blocks to make all hashes correct again, it will not match the blocks of other nodes in a network. Nodes always work on the longest chain and consider that chain to be the correct one, meaning that the Blockchain can only be maliciously altered by maintaining more than 50% of the computational power in the network. For a technical explanation of the cryptography underlying the Blockchain, the above should provide sufficient to deal with Blockchain in this research. For additional reading material, see Nakamoto, 2008. His whitepaper on Bitcoin provides the first basis of Blockchain knowledge.

The mechanisms underlying the concept of Blockchain technology over all fields of Blockchain technology can be captured under the name of consensus mechanisms. The consensus mechanism of a Blockchain is the concept that replaces trust in third party with trust in cryptography.

2.2.2.2 Types of Consensus Mechanisms

The Bitcoin Blockchain, as mentioned, operates on a PoW-basis, which means that the consensus mechanism is based on the longest chain, as most CPUs are working on that chain. Many of the current Blockchain technologies use this methodology in their system. Apart from Bitcoin, other big names that use PoW are Litecoin, Ethereum, Dogecoin, Verge, and ZCash. Mining is the process of choosing a nonce that has a hash that starts with a set number of zeros. The work itself does not add to the productivity of the Blockchain, it merely aims to create consensus over the data in the chain. Because miners are incentivised to perform the calculations through monetary compensation, there is an incentive to allocate CPU to the longest chain. This chain is the one that is accepted as being true by the system. Therefore, as mentioned in the earlier section, a Blockchain that relies on PoW is safe as the work being done by more than 50% of miners is honest.

Another widely used consensus mechanism is Proof of Stake (PoS), this consensus mechanism replaces the allocation of CPU to solving mathematical problems with a 'stake'. This stake can be defined as several variables but was first proposed to encapsulate only wealth. This means that block validation is no longer done by the mathematical transaction of mining the nonce to get the required hash, but the block is now validated by a randomly selected stakeholder (Kiayias, Russell, David, & Oliynykov, 2017). Well-known systems that use this system to run their Blockchain are Peercoin, NxT, and Decred. Also, Vitalik Buterin, founder of Ethereum, has announced that he aims to incorporate the Proof of Stake concept in the Ethereum Blockchain, which run traditionally on a PoW system (Gray, 2018). Incorporating the miners into the stakes of the network has beneficial effects regarding the amount of effort needed to validate blocks. As the stakeholders have an inventive to perform their validations in an honest manner, so as to not hamper the integrity of the system and in extension their own stake, there is no need for difficult mining operations to provide a limitation to wrongdoing. The larger the stake a miner has, the larger their ability to process blocks. Meaning, the responsibility only grows as the incentive to act 'honestly' also grows. Variations to this consensus mechanism could be random selection without necessity of stake-holding, as random allocation of allowance of mining capacity is highly unlikely to provide any incentive to verify faulty data. Another method is based on coin-age. This system allocates the mining authority to holders based on the amount of time they have held a set amount of coins. However, once used to verify a block, the number of days saved is put back to zero again and the holder must save up again. Criticism on PoS consensus mechanisms manifest themselves in the 'nothing-at-stake' problem, which identifies the situation in which a stakeholder has no incentive to resolve distributed consensus in case of a failure of the system, which induces double-recognition (Chepurnoy, 2016).

A third system that has gained increasing attention over the last years is a Delegated Proof of Stake (DPoS) system, which is similar to the aforementioned Proof of Stake. The biggest difference is what is allowed to people with high stakes. These, in contrast with PoS, are not the ones who decide what the next block on the chain is but rather, they decide who does. You could argue that DPoS is a cryptographic version of democracy (Zheng, Xie, & Dai, 2017). In the system, the level of stakes a node holds, determines their ability to weigh in on the selection of delegates. These delegates then decide which transactions are valid and which ones are not. Once a delegate is no longer doing its work properly, the ongoing voting system shifts towards a replacement, which then takes over. Since there is a strong monetary incentive for delegates to remain appointed as delegates, they will try to keep the community happy by performing the validation of the transactions in an honest and efficient manner. Because of the structure that DPoS systems have, the processing time of block creation is much faster. After all, the structure is now such that miners can collaboratively create blocks, severely diminishing the time it takes to create a block. Important Blockchain-based DPoS systems are Lisk, EOS, Steem, and Ark. All with remarkably high processing speeds. However, it has been criticized that the system is too centralized. Choosing only a limited number of delegates to verify transactions puts them in a position of power that, at some level, could be exploited. Also, the correlation between the level of monetary stake and quality of delegate assessment is not proven.

To put the situation very plainly, the stakeholder with the highest level of monetary, and as such elective, power might be very ill equipped to validate the quality of a delegate to run the system. The richest are not necessarily the smartest.

A fourth consensus mechanism is the Byzantine Fault Tolerance (BFT), which is a solution to the Byzantine General's Problem. This problem identifies a number of generals surrounding a city, all of whom have to make a decision to attack or to retreat. Any decision that is made without consensus with the other generals will end in a failure. However, the generals have no information about either the validity of the messaging structure, nor about the integrity of the other generals. In other words, how do these generals reach consensus if the possibility exists that one of them is deliberately feeding misinformation or that information will simply not be transferred correctly or at all? One of the solutions to the problem is to open communication channels between the generals so as to provide verification of the message as sent by the general requesting action (Lamport, Shostak, & Pease, 1982). The receiving parties then distribute their entries with each other and act according to a majority of received actions. Following the assumptions made in the first solution of the paper by Lampor, Shostak and Pease (1982), a proposed transaction needs only to be distributed amongst three nodes so as to ensure a valid outcome, should one of the nodes, even the 'commander' or the node making the request, is malicious. The first implementation proposal was written in 1999 by Miguel Castro and Barbara Liskov, who created the first algorithm able to tolerate Byzantine Faults in the nodes of a network, the Practical Byzantine Fault Tolerance (PBFT) algorithm (Castro & Liskov, 1999). This structure is one of the fundaments of consensus algorithms but is only able to cover Byzantine Faults, meaning a deliberate attempt to distort the network mechanisms by providing a request to a different action to different nodes. However, if the request that will be made is uniform but malicious in the contents of the message, the PBFT algorithm will not be able to rectify the resulting transaction. In practice, this means the system is only moderately useful for networks in which the anonymity of nodes is important. An adaption of the PBFT is used by Stellar, the Federated Byzantine Agreement (FBA), which used 'slices' of nodes to verify chunks of data before sending the low-level consensus to the rest of the network (Mazières, 2015). This makes the use of the Byzantine Fault Tolerance possible in systems where accessibility is not restricted.

The last type of consensus mechanism that will be discussed is the Directed Acyclic Graph (DAG), which is not actually a Blockchain, i.e. it is not a chain of blocks. Instead of one chain, the transactions are linked to a network of transactions, all linked to each other in a non-linear fashion. The validation of transaction happens by randomly assigned nodes, who are other nodes creating transactions. Once a transaction has been made, the transmitter of the transaction has the obligation to validate two other transactions. To explain Directed Acyclic Graphs more extensively, the Tangle paper of IOTA will be reviewed (Popov, 2017).

Popov identifies one of them major flaws in the current state of Blockchain technology. In particular Proof of Work-based Blockchains, such as Bitcoin, require a transaction fee for the work that has been done to validate the transactions. The miners need to be incentivized to validate transactions, irrespective of the size of those transactions, which could induce monetary compensation of a transaction to supersede the value of actual transaction. Popov recognizes that with the introduction of Internet of Things (IoT), the need for many small transactions is likely to increase. The limitation of the PoW-systems would limit the application of the consensus mechanisms in IoT networks. What Popov proposes to rectify this problem, is the Direct Acyclic Graph, which incorporates the roles of the transactional nodes and the miners. As a transaction is made by an account in the network, it is assigned two transactions it must validate. This happens in a random manner so as to limit the possibilities of malicious strategic use of the validation approval. The transaction occurs by the node choosing two transactions according to an algorithm and checking whether those transactions are not conflicting. If they are, these transactions are not accepted. After it has validated the transactions, it adds its own transaction to the graph, and finds a nonce for the hash to conform to a certain standard, just like in a PoW-system. However, because the transactional node

is now the same as the mining node, the speed with which this process takes place is much quicker. The safety of the system comes from the obligatory validation before the transaction is added to the graph. Due to the double transaction verification by a transactional node, the system will become faster, and better protected against attacks as it grows. Scalability should be better dealt with in this consensus mechanisms than typical PoW or even PoS-systems. As the computational weight of computers is likely to strongly increase over the years, even considering the possibility of quantum computing, the system is protected against weight-based attacks by simply capping the transactional level that a node can supply to incur the majority of validity power. This would not hamper the system, especially not in the case of a large user-base as a scenario where productive use is gained from possessing more than a third of the entire transactional system is very unlikely.

There is a number of additional systems providing solutions to the difficulties with anonymized consensus over the internet, however, for now, the above provides enough background. Two other dimensions of characteristics of Blockchains need to be discussed to provide a complete overview of the technology and to create some degree of unity in definition of Blockchain technologies (Sharron & Tuckett, 2016). Namely, the dispersion between private and public Blockchains and the difference between permissioned and permission-less systems (see figure 9). The consensus mechanisms of Blockchain structures can be categorized according to these two indicators. The first dimension is public versus private, which is easily explained. A private system is accessible only to a limited number of people. Private systems are more controlled and can, as a result of their restricted anonymity of the validating parties, make use of the beforementioned systems based on the Byzantine Fault Tolerance.

The other dimension is the Permissioned versus Permission-less characteristic. This determines the level to which participants in a network can validate transactions that happen within the network. This characteristic implies the level of trust in the validators. The original Blockchain, Bitcoin, was Permission-less and public, meaning there is a high anonymity of the validators and no mutual trust in the network. In practical terms, in a public, permission-less system, anyone can gain access to the system and validate transactions in the system without being scrutinized per pre-determined validation mechanisms.

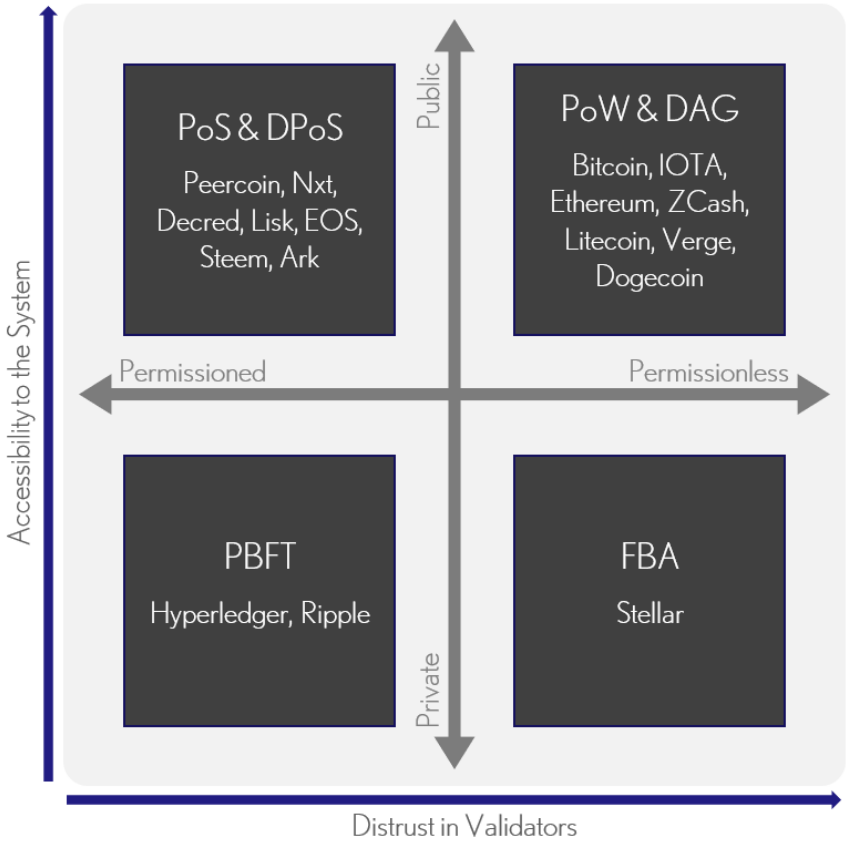

Figure 9 - Dimensions of Blockchain Technology Characterization

It is to be expected that these dimensions might not lead to limitations, or contributions, to the appropriation of intellectual property rights for a technology that uses Blockchain technology. After all, in the formulation of limiting factors in an intellectual property right, the scope of the invention must be as broad as possible to prevent others from infringing on the technology by making small changes. In light of this, it would be unwise to limit the scope of protection to a very specific type of Blockchain, or a definition of the above dimensions. It would be more beneficial to keep the terminology of the consensus mechanism broad so as to keep a scope of protection that is wide. However, with respect to the above dimensions, some issues might be raised.

One question that might come to mind is what the added value of a Blockchain technology is, in a very private network. How many fundamentally private networks have serious problems with trusting a third party within that group? While developing use cases for the technology, some Blockchain enthusiasts lose track of what the fundamental benefit of a Blockchain technology is, namely a trust-less system. If the trust already exists in a network, there simply is no need for Blockchain technology. The system could then also be created by using various other methods, without using the abovementioned consensus mechanisms for the implementation of a trusted transaction system.

These private systems could be used in supply chain systems, as argued in literature and use case articles on the technology (Pilkington, 2016). However, the use of the technology does not prevent mistakes, a supply chain environment might benefit from a distributed ledger system to keep track of logistic operations, but this does not necessarily mean there is a lack of trust in the third party supplying the information now. A cloud computing system or a synchronized working system could prevent discrepancies in that data as well. Simply using a Blockchain system to prevent faulty input data is not possible, as often is proposed by advocates of the technology. The point of this paragraph is to provide some insight into applications of the technology (and as such, the need to protect the intellectual property), in light of the above explanation of the technology.

Further, matters of infringement are affected by the degree of privatization and permission in the system. If the access to a system is protected and controlled, the proprietor of the technology can track infringement actions and even prevent them with ease. If the system if completely public, proving the infringement by a commercial party, even if it is in the correct jurisdiction, is difficult (Guo, 2017).

Finally, regarding the distribution of the technology over the aforementioned dimensions, the existence of a highly permissioned system might be beneficial for the efficiency of the technology, as the amount of validation work done by miners is reduced. However, pending a definition of a definition of the technology, the criticism on these Blockchains for being too centralized might be justified. It is unlikely that these dimensions will play a large role in the appropriation of intellectual property rights for Blockchain inventions but are important to consider regarding the battle for standards, or the practical use that one might have for the system.

2.3 Blockchain and Intellectual Property Law

The following section will provide an overview of the available literature regarding the combination of intellectual property law and Blockchain technology. As mentioned, there is a limited quantity of literature available that discusses the protection of intellectual property of Blockchain technology applications. What follows is a broad selection of the combination of the two subjects (table 4).

Table 4 - Literature for Blockchain and Intellectual Property Law

Author(s)	Year	Title	Journal	Subject
Durell	2000	Intellectual Property Protection for Computer Software: How Much and What Forms is Effective	*International Journal of Law and Information Technology*	IP Law and Software
Fairfield	2014	BitProperty	*Southern California Law Review*	Property and Blockchain
Guo	2017	Blockchain Receipts: Patentability and Admissibility in Court	*Chicago-Kent Journal of Intellectual Property*	Use of Blockchain in court
Ishmaev	2017	Blockchain Technology as an Institution of Property	*Metaphylosophy*	Property and Blockchain and definition of property
Zeilinger	2016	Digital art as 'Monetized Graphics': enforcing intellectual property on the Blockchain	*Philosophy and Technology*	Blockchain as tool for IP law

A first paper that combines the two merely identifies the limited ability of intellectual property law to protect intangible digital property rights, as mentioned in the previous explanation of the changing character of intellectual property law (Fairfield, 2014). This view on the combination of intellectual property law and Blockchain technology is identified in other research as well (Zeilinger, 2016). Fairfield also indicated that the definition of property is changing as a result of the implementation of distributed systems. Property, he argues, is becoming less tangible and as the digitization of the markets is increasing, property of information is becoming more valuable than property of tangible products. Property law, therefore, has to change as to support the property rights of intangible assets such as information. Only then is it possible for the regulatory system to provide a working intellectual property system, which is suited for concepts that include distributed ledger technology. In the scope of this research, the paper by Fairfield clearly stipulates why protecting Blockchain applications is difficult. The current patenting system has difficulty defining property in the digitized domain, especially with regard to decentralized ledgers, which are fundamentally 'not owned'. This difficulty, along with the risk of changing legislation poses limitations to the viability of a patenting strategy. The gap between emerging technology and intellectual property law as a result of increased globalization and a decentralized nature of this technology and by extension the need for an intellectual property law system that has the ability to deal with this increasing gap is clearly stipulated by Fairfield. The solution that Fairfield provides, an *"… operational system of digital property"* would merely be an addition to the existing field of intellectual property at best as it does not take into account the effects of tangible property. The field of intellectual property law then, would have to be separated between digitised intangible property and 'real-life', tangible property. Before such a dramatic adaptation to intellectual property law is at all possible, this research provides a structured approach to dealing with intellectual property law and emerging technology that does not require any adaptation of the law.

The 2017 paper by Ishmaev advocates the possibility of Blockchain as an institution of property. Here, Ishmaev argues that Blockchain could help reengineer property law (Ishmaev, 2017). Blockchain has the possibility to enforce property rights as it maintains a structured overview of transactions within the distributed ledger. The addition of Blockchain to the existing structure of intellectual property law is the universal recognition and trust in the transparency of the system by all users in the network. This, however, does not identify the legal structure of property rights regarding the Blockchain itself. Ishmaev offers his explanation of Blockchain as an institution of property from the concept of property as defined by Penner in his 1994 paper about the idea of property in law and the 1991 book by Hegel, Elements of the philosophy of Right, which is the concept that will be used in this thesis as well, which rests on the fundament of exclusivity, separability and recognition. Property, following Penner and Hegel, is the ability to exclude use or possession of an assets to others and transfer these rights (Penner, 1997) and recognition of those rights (Hegel, 1991), also see section 2.1.3.

Another paper that captures both intellectual property rights and Blockchain, is written by Angela Guo in 2017. She investigates two aspects of Blockchain technology in intellectual property law; the admissibility of Blockchain-produced receipts in court and the patentability of Blockchain technology. With regard to the patentability of Blockchain technology, she argues that the distributed assets produced by a Blockchain are likely not to be patentable. In other words, most likely, it is impossible to patent a Bitcoin. However, it may be possible to patent the underlying technology. In fact, companies are, as mentioned, rushing to patent all sorts of inventions that use Blockchain technology. According to Guo (2017), *"patents have emerged as the primary mechanism thus far for those seeking to protect their claims and uses of technology… But for now, only time will tell if such a revolutionary technology can be claimed as intellectual property – or be used in court"* (p. 452).

In the field of intellectual property law, it is likely that comparisons can be drawn from the protection of intellectual property rights of computer software. To do this, the 2000 paper by Karen Lynne Durell will be reviewed. She shows the difference in legislation by different countries regarding intellectual property rights for computer software and advocates the notion that a structural reform of intellectual property law is needed to rectify the problematic current state of the field. The paper is likely to provide an insight into the problematic aspects of software protection and as such, Blockchain technology applications, as well as an insight in the ability of current law to deal with the claim to patentability (Durell, 2000).

2.4 Summary of Literature Review

The above sections provided necessary background information for the development of this research. Intellectual property law has been discussed extensively, by inclusion of the most relevant types of rights in this field, namely copyrights, trademarks, industrial designs, geographical indications and patents. It has been concluded that both copyright and patents are eligible for protecting the intellectual property of Blockchain technology applications. This will be further elaborated on in chapter 4. In consideration of intellectual property law, the definition of property has been discussed, following the aforementioned definition proposed by Ishmaev by inclusion of Penner and Hegel so as to develop three indicators for property; exclusivity, transferability, and recognition. Furthermore, the ownership of data has been discussed, to which the most practical solution in light of intellectual property law is the allocation of ownership through the creation of the data, as proposed by Locke in his 'sweat of the brow' theory and Foucault by his interpretation of data authors. An open question resulting from this discussion is the legal possibility of ownership allocation through data appropriation. It is yet to be seen whether the appropriation of data is fundamental grounds for physical asset allocation and should be determined by the level of admissibility in courts. In addition to the property definition and issues, the relationship between IPRs and innovation has been discussed. The general finding in scientific literature is that IPRs have a positive effect on innovation, as long as the innovation is not too disruptive. As soon as legal flexibility is needed, the effects of IPRs on innovation are argued to be negative. A disruptive invention that does not 'fit' in the current state of IP law does not seem to benefit from the system.

In addition to the field of intellectual property law, Blockchain has been explained to a high detail. The fundamental system as proposed by Nakamoto in his Bitcoin whitepaper has been discussed, followed by several prominent consensus mechanisms such as Proof of Stake, Proof of Work, Delegated Proof of Work, Practical Byzantine Fault Tolerance, Federated Byzantine Agreement and the Directed Acyclic Graph. These can be classified along two dimensions, level of permission to perform the mining activities and the level of privacy of the network. In this framework, Proof of Work is public and permission-less, while the Practical Byzantine Fault Tolerance is private and permissioned. Regarding these dimensions, the conclusion was drawn that the type of Blockchain technology is unlikely to affect the appropriation of intellectual property rights. However, the degree of privatization might lead one to consider the necessity of the technology in a network where there is likely to be no demand for decentralized trust. And whether the Blockchain is permissioned or permission-less might play a role in standard battles as a permissioned Blockchain technology might not be considered a Blockchain technology under the implementation of pending standards definitions.

Finally, the combination of intellectual property law and Blockchain technology has been researched in existing scientific literature. While the existence of such literature is scarce, some interesting conclusions could be drawn from this limited amount. First, most scientific literature merely identifies the existence of Blockchain technology as a solution to be implemented in the current system of intellectual property law, rather than using intellectual property law to protect inventions that use Blockchain. Referencing to the literature on the fit between emerging high technology and intellectual property law, also see chapter 1, Blockchain technology exemplifies a volatile, disruptive, high technology that does not fit together with intellectual property law very well. The solutions generally proposed to solve this problem is to adapt, abolish, or radically transform the IP law system. What is not discussed in any of the identified literature, is solving the problem by closing the gap between intellectual property law and high emerging technology, such as Blockchain technology, by generating a flexible method for using the law to protect the intellectual property these technologies. The gap in the scientific literature then, which this research proposes to fill, is how to align intellectual property law with emerging high technology, without negatively influencing innovation and without disrupting intellectual property law.

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3 Methodology

"A good conductor ought to be a good chauffeur; the qualities that make the one also make the other. They are concentration, an incessant control of attention, and presence of mind; the conductor only has to add a little sense of music"

– Sergei Vasilyevich Rachmaninoff –

This chapter will provide an overview of the structure with which the research questions as proposed in chapter 1 will be answered. First, the creation and the validation of a theoretical decision-making framework will be discussed following existing scientific literature, followed by a disquisition of the research material.

3.1 Creation and Validation of Theoretical Decision-Making Framework

This section will provide the background for the creation and validation of a theoretical decision-making framework by considering the theoretical background as described in scientific literature, followed by the practical execution of the research. Finally, a consideration will be made regarding possible substitution of the technical subject-matter, Blockchain technology applications, for comparable technologies that might prove to be more adequately represented by literature or other resources.

3.1.1 Theoretical Background

The following literature will be considered in deciding how to approach the development of creating a theoretical decision-making framework and the subsequent validation of said framework (table 5). This literature should provide the necessary information of the development of a theoretical decision-making framework and the validation of said framework so as to answer the main research question as proposed earlier.

Table 5 - Literature for Methodology

Author(s)	Year	Title	Journal	Subject
Cane, O'Connor & Michie	2012	Validation of the theoretical domains framework for use in behaviour change and implementation research	*Implementation Science*	Validation of Conceptual Framework Methodology
Ferrell & Gresham	1985	A contingency Framework for Understanding Ethical Decision Making in Marketing	*Journal of Marketing*	Use of Conceptual Framework to diminish knowledge gap in theoretical literature
Kim, Cho & Rao	2000	Effects of consumer lifestyles on purchasing behaviour on the internet: a conceptual framework and empirical validation	*Association for Information Systems*	Development and validation of conceptual framework for decision-making
Newman, Papadopoulos & Sigsworth	1998	Barriers to evidence-based practice	*Clinical Effectiveness in Nursing*	Possible limitations to the use of evidence-based practice due to organizational limitations

Author(s)	Year	Title	Journal	Subject
Snowden & Boon	2007	A Leader's Framework for Decision Making	*Harvard Business Review*	Development of decision making framework for dealing with complex contexts
Subramoniam, Huisingh & Chinnam	2010	Aftermarket remanufacturing strategic planning decision-making framework: theory & practice	*Journal of Cleaner Production*	Development of empirically validated conceptual decision-making framework
Tan, Liu, Cao & Zhang	2002	A decision-making framework model of cutting fluid selection for green manufacturing and a case study	*Journal of Materials Processing Technology*	Development of decision-making objective framework and validation through case study

Considering the aforementioned papers, we can develop a method for creating a theoretical framework and subsequently validating said framework by use of case comparison. First, the papers above will be discussed very briefly, after which parts of the literature will be considered in developing a strategy to create and validate a theoretical decision-making framework. First, Farrel & Gresham show the possibility to close a *"significant gap in the theoretical literature"* by creation of an integrated framework (Ferrell & Gresham, 1985). This at least points towards the possibility of closing the aforementioned gap between the law and emerging technology by means of development of a decision-making framework. Furthermore, Snowden and Boone show the possibilities of using a framework for structuring complex contextual situations for decision-making (Snowden & Boone, 2007). They show that the characteristics of the context in a situation determine the way in which the situation should be dealt with by a leader, and how he should respond to certain signals. While the aim of their research lies in the general field of business and leadership, their system of identifying a situation's characteristics to determine an appropriate response can be used in the development of a theoretical decision-making framework in this research.

Tan et al. show that the validation of an objective framework is viable through case study (Tan, Liu, Cao, & Zhang, 2002). They acknowledge the possibility to structure complex situations by adapting a theoretical decision-making framework to case-based feedback so as to create an objective framework (or a validated framework. With respect to this research, the development of an objective framework is interesting. It might be valuable for proper hypothesis testing to develop such a framework. This type of framework creation is also done by Kim et al., who use the same approach to their research (Kim, Cho, & Rao, 2000). It should be noted though, that both papers, by Kim et al. and Tan et al., denote very specific relationships that are tested by case study in a quantitative approach. It is highly unlikely that this research would allow for such an approach as it is limited in the level of theoretical causal relationships that can be quantitatively tested. The approach as put forward by the two papers is also contested by Newman et al. in their 1998 paper. They propose significant barriers to evidence-based practice, through organizational structures and cultures (Newman, Papadopoulos, & Sigsworth, 1998). It is likely that the situation they describe will also provide barriers in the implementation of the framework that this research will produce.

For that reason, although case-based feedback will be implemented in the theoretical framework, it is to be expected that the objective framework will not be based on uncontested quantitatively determined relationships. The effects of implementation of such a framework will teach the validity of the framework in various stages of development. Lastly, Cane et al. propose a method for validation of a theoretical framework through domain identification and subsequent comparison of domain content with outcomes

(Cane, O'Connor, & Michie, 2012). An adaptation of their proposal will serve as the structure of the validation of the framework that will be developed later in this research (figure 10). The next section will explain the practical approach to the development and validation of the framework in this research, using the teaching of Cane et al.

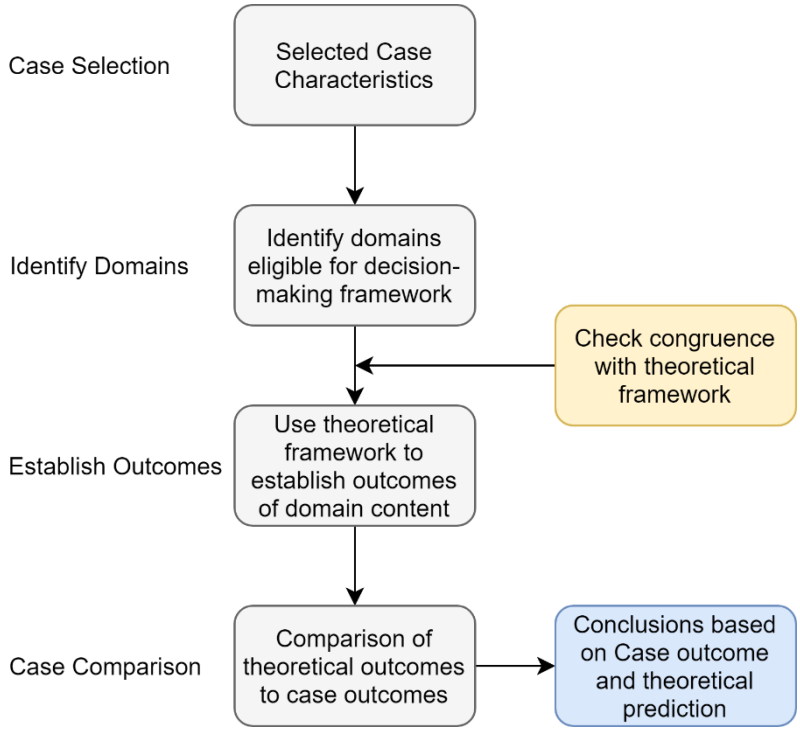

Figure 10 - Method for Case Comparison (adapted from Cane et al, 2012)

3.1.2 Practical Execution

As section 1.4 specified, this research will include the development of a theoretical decision-making framework and subsequent validation of that framework. These steps will be explained in this section. First, the theoretical framework will be constructed. This will be done through analysis of the choices that can be made in the procedure of protecting intellectual property rights of Blockchain technology applications and looking into the factors that influence the outcomes of these choices. For the theoretical decision-making framework, it should be noted that only literature and the law will be considered. There will be no adaptations, however obvious to the trained eye to the framework based on experiences in the field of intellectual property law. This will be added later, as the framework will be compared to case law, patent analysis and guidelines. Once the factors that influence the choices in a protection procedure have been identified, their relationship will be structured according to existing literature and the law so as to establish a structure in which these effects are shown. This should then lead to a framework per choice that needs to be made. Referring to the literature as described in the before section, the theoretical decision-making framework is likely to be objective to a higher level than the validated decision-making framework as the validation allows the subjectivity of the law to 'seep' into the law-based theoretical decision-making framework.

Once these theoretical frameworks have been established, the relationships tested by connection with available data. Patent data is widely available – especially through licences of HRM – and should provide additional insight into the validity of the relationships that were produced earlier. Where applicable, the relationships that were described in the theoretical framework will be adapted so as to include this data. Once the data has been included, the framework will be compared to case law and guidelines to validate the theoretical model. This will be done per the aforementioned structure (figure 10). Here, cases will be selected, and structured as having a 'positive' or a 'negative' outcome. The validity

of the theoretical framework will then be dependent on the link between the outcome being strong in positive cases and weak in negative cases. Once case characteristics have been determined, the domains on which the framework can be applied will be identified. Some choices as described above might not exist in certain cases. Therefore, the choices that are relevant must be determined and subsequently must be validated as fitting in the framework (see yellow block in the above figure). Once the choices and the characteristics are known, the theoretical framework can be used to establish outcomes of the domain content, which then can be compared to the outcome of the case. This will lead to the conclusions as described above, dependent on the either positive or negative outcome of the case per choice as provided in chapter 4.

3.1.3 Technical Substitution

When dealing with a novel technology, especially one accelerating in its development as fast as Blockchain does, data might be elusive. To determine what will happen with the technology as it matures, drawing comparisons with other technologies that followed a similar path in the past might provide insights into the development of the technology in the future. To do so, in the case of Blockchain technology, in several parts of the research comparisons are drawn with the development of Software in general and other technologies who, in term of development, have followed a similar path as what it looks like Blockchain is following. As Blockchain is an IT-based system that facilitates transactions, we might draw upon data from case law from both transactional inventions and software inventions. Preference will draw towards relatively new and fast-growing technologies in the last two decades that are based on software as that will also constitute 'non-patentable' material, which draws close comparisons with Blockchain technology. The use of substitutes for case law comparison will likely strengthen notes made by Newman et al. as it further estranges the validity of applicability (Newman, Papadopoulos, & Sigsworth, 1998). When applicable, the substitutive technology and adherent case law will be discussed in chapter 6.

3.2 Material

3.2.1 Sources

To perform the research, HOYNG ROKH MONEGIER has provided access to case law information, internal literature and external guidelines from patent offices. This information will be used to determine the effects of the protection mechanism, given the characteristics of the Blockchain technology applications that are determined by the theoretical decision-making framework and as such the validity of said framework. Furthermore, the possibility exists to draw upon expertise from within the firm and their experience with devising protection mechanisms for Blockchain applications. Finally, and possibly superfluously, the firm has a high degree of expertise regarding intellectual property law and has provided the possibility to cooperate in prosecution, appeal, opposition, and litigation cases so as to strengthen the knowledge base necessary to write this research.

For analyses regarding patents, PatBase and Google Patents will be used. PatBase is a very powerful patent search engine, with analytic tools built in (PatBase, 2018). It has the ability to search through all major databases over the world and has access to over 109 million patens from over 104 countries. It is the most extensive patent search engine and will be indispensable for the gathering of data about the patents. For individual patent analysis, Google Patents will be used. Having an enormous number of patents in the database and allowing extremely fast access to the contents of these patents, Google Patents is an excellent tool for the patent analysis, as this requires the fast screening of hundreds of patents for determination of inclusion in the research, something that would not easily be done with PatBase.

Before the effectiveness of the protection strategies, given certain characteristics of the Blockchain applications, can be analysed, the types of protection strategies and the characteristics to be analysed must be determined. Types of protection strategies will be analysed using the law, the possibility to include a combination of protection mechanisms will be discussed as well, albeit only from the perspective of intellectual property law. This entails that the discussions about first-mover advantages and strategic market entry will be avoided. Protection mechanisms are herein referred to as being what is supplied by intellectual property law.

To determine the choices in the use of these strategies, we look at the relevant law and guidelines for the operation of that law. Where applicable, this will be supported by literature. However, since the theoretical decision-making framework is as objective as possible, the literature will not be used to predict the relationships of characteristics of the technology and the choices to be made in the framework. Literature will to the effect of the theoretical decision-making framework only serve as background and methodology of the development of the theoretical decision-making framework, rather than being leading in the determination of the relationships within the framework. With regard to the limited timeframe of the research, only the widely used strategies will be analysed to determine their requirements.

Finally, the characteristics of Blockchain applications that affect the effectiveness of the protection strategies will be determined by looking at the beforementioned requirements for strategies along with the components of Blockchain technologies that are generally protected under certain mechanisms, answering sub-question 2 will help identify what aspects of the technology are likely to influence the outcome of the decision-making framework. These are again determined by the law. However, as earlier, literature supports the development of the framework so as to identify the functions of the technology that are likely to influence certain choices in the framework.

Naturally, over the entirety of sub-questions 1 to 3, literature will be used to match the law with the technology where possible. The best protection mechanism for Blockchain technology applications cannot be determined without extensive knowledge of the technology. As such, literature will be used over the entirety of the following chapters, albeit not specifically to denote the effects of certain characteristics in a decision-making framework.

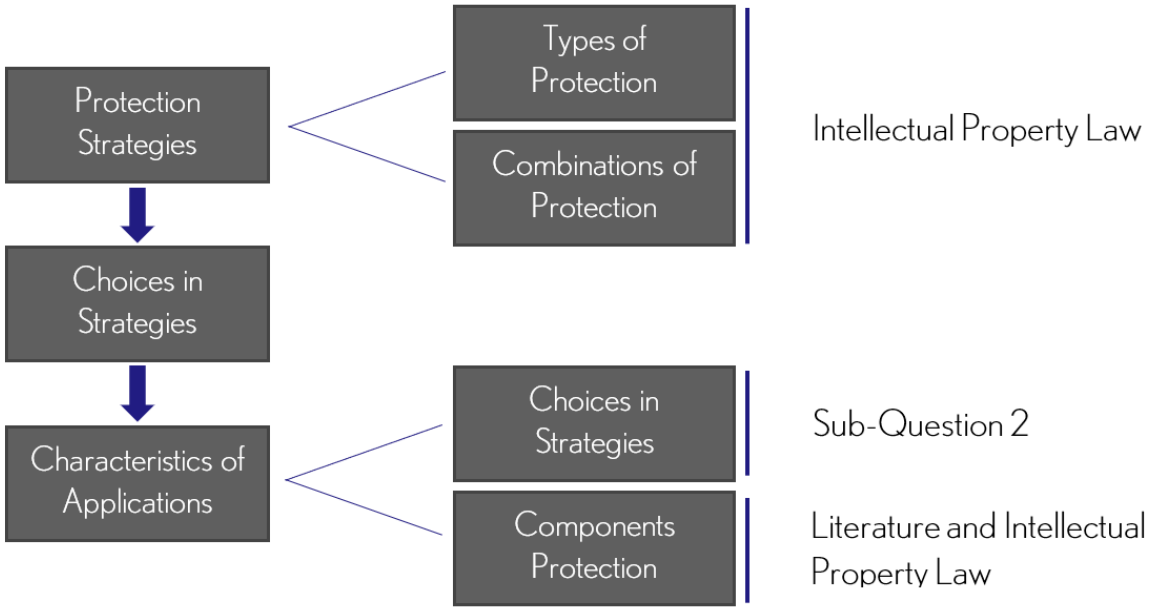

Figure 11 - Method Sub-Questions 1 – 3 Using Law and Literature

When the first three sub-questions have been answered, the theoretical decision-making framework must be constructed, after which the relationship between a strategy and its effectiveness, given characteristics of the Blockchain application can be researched. As mentioned, this will be done using case law and in the categories of the granting procedure of patents and infringement litigation, possibly with substitution of technologies that are better represented in case law. In addition to the case law, patent analysis will be used to determine best practices for protection mechanisms. Finally, guidelines by patent offices will be considered, as these are based on case-law and are quite strongly adhered to by national courts. As such, they provide a solid foundation for the determination of the validity of the theoretical decision-making framework.

Firstly, a patent analysis will provide feedback to the theoretical decision-making framework by adding a factual interpretation of the protection mechanism to the decision-making framework. This will be done per the inclusion of data on the granting rates of patents using Blockchain technology in general. Furthermore, the granted patents will be analysed per the type of technology they protect and the way in which the protection scope is formulated. An elaboration on the reasons behind these measures is provided in chapter 4.

Once the theoretical decision-making framework has been subjected to data from the patent analysis, the framework will be adapted so as to include case law of cases in prosecution and in infringement. The measures of effectiveness by using case law are shown in the figure below. As shown, cases from both patent prosecution as infringement will be used. Concerning patent prosecution, we will analyse both cases against the grant of a patent (opposition) and the cases against refusal of the patent application (appeal). Cases in the granting procedure aim to dispute or establish the validity of the grant of the patent. In opposition, this can be disputed by parties who have an economic interest into the technology for which the application is filed. In appeal, this is done by the patent office, which can decide the claims do not constitute a patentable invention. If the applicant disagrees, appeal procedures can be commenced. Infringement litigation concerns itself with the exclusive right to use a technology, infringement cases often aim to exclude a third party of the use of a technology because the proprietor holds a patent to that technology. The effectiveness of the proposed strategy will be tested by looking at the rate of victory in appeal cases, opposition cases, and infringement litigation cases.

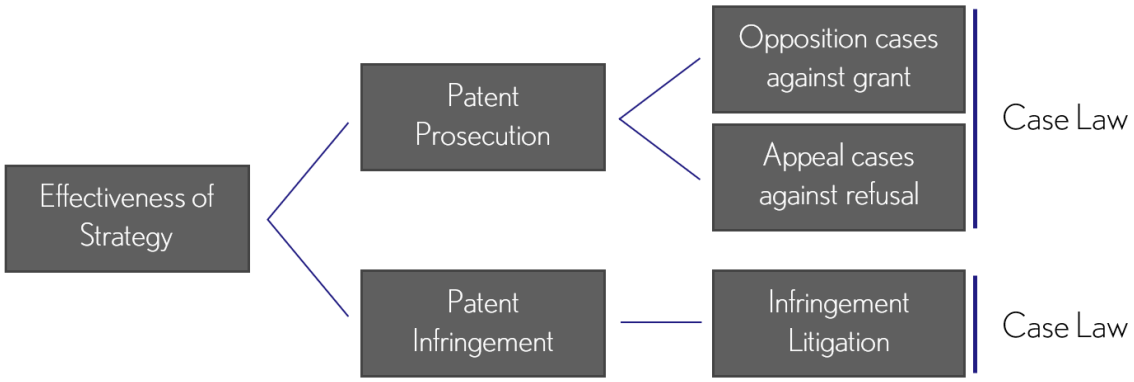

Figure 12 - Method Sub-Question 5 using Case Law

In addition to the above, guidelines will provide insight into the development of claim formulation in patent prosecution. All patent offices provide patent attorneys with guidelines for the development of patent applications. This is in addition to the law and provides the patent attorney with a comprehensive overview of practical matters, usually based on applicable case law. The application of these guidelines will allow the theoretical decision-making framework to encapsulate broad case law deemed important by the institutions providing the grant (or refusal) of the patent.

3.2.2 Participants

The supervisor at the company is Peter Haartsen, patent attorney. He specializes in IT and has expertise on the subjects of electrical engineering and telecommunication. At the Delft University of Technology, my main supervisor is Jeroen van den Hoven and second supervisor is Zenlin Roosenboom-Kwee. Both have extensive experience in both strategic management and IT applications in business, in particular the use of Blockchain technology applications.

Furthermore, help is offered from within HRM to facilitate the production of the research as well as procedural knowledge by working on cases in both prosecution and litigation. This will allow for a full view of the world of intellectual property from within HRM.

3.3 Summary of Methodology

During the execution of this research, as explained in the earlier chapters, a theoretical decision-making framework is to be created and validated. Literature shows that the application of such a method to close a generic gap between the literature and the law is possible. Also, the application of case-based qualitative measure to develop such a framework for solving complex issues look to be viable.

To develop the theoretical decision-making framework, the law will be analysed, along with literature on the technology to be protected. The protection mechanisms will be analysed, and the best mechanism will be analysed to determine what choices must be made in the application of this mechanism. Once the choices are clear, features of the technology that will influence these choices must be analysed. These will subsequently lead to the development of a theoretical decision-making framework.

The theoretical decision-making framework is subjected to two types of improvements. Those based on a patent analysis and those based on case law. The patent analysis will identify successful patent applications that have resulted in granted patents. Characteristics of these patents will be analysed and included in the considerations for improvements of the theoretical decision-making framework. Furthermore, case law will provide information about procedures on these patent applications. The results of these cases will be used to qualitatively adapt the decision-making framework further so as to arrive at a completely validated decision-making framework. Guidelines will provide the final set of case law, provided by patent offices, to specify final matters on claim formulation in patents for the protection of intellectual property of Blockchain technology applications.

Should there be a lack of literature, case law, specific guidelines or other barriers to the development of a framework, there exists the possibility of technology comparison. Certain aspects of Blockchain technology applications can be seen in other technologies that might be more mature. As such, these technologies have a more prominent presence in the field of intellectual property law. A trade-off is created between complete information and the alignment of the technology with the subject of this research.

4 Protection Strategies

"We must always work, and a self-respecting artist must not fold his hands on the pretext that he is not in the mood. If we wait for the mood, without endeavouring to meet it hallway, we easily become indirect and apathetic."

– Pyotr Illyich Tchaikovsky –

This section aims to determine what strategies for the protection of intellectual property rights for Blockchain technology applications exist. This will be done according to the information provided in the previous sections. Both the technological characteristics of Blockchain technology will be considered, along with the intellectual property rights as discussed. After the consideration regarding the type of intellectual property right most suitable for the protection of intellectual property rights of Blockchain technology applications is made, specific choices in this field of intellectual property law will be discussed.

Specifically, for the protection of Blockchain Technology, the two most evident intellectual property rights are copyright and patents as provided in chapter 2. Even though the core of the subject-matter has been published and therefore no longer has grounds for patentability, because the Blockchain is now part of state of the art, the technical effects of a solution as provided by an invention on the fundament of Blockchain technology might be patentable (Guo, 2017). As for copyright, the code as written by developers of the invention is automatically protected as explained in section 2.1.2.1.

4.1 Structure of Blockchain Technology for Intellectual Property Law

To identify the parts of a Blockchain technology that are eligible for protection via patents or copyright, we must distinguish various parts of the technology. The Blockchain will be described as structured by the base layer, the Distributed Ledger, followed by a middle layer, the Smart Contracts, and finally the top layer, the technical effect of the invention making use of Blockchain technology.

Fundamentally, the 'Distributed Ledger' comprises the method in which the transactions occur. This base layer of Blockchain technology constitutes the combination of the consensus, mining, propagation and the semantic layer, as they may apply to the technology in question. The consensus layer is the methodology of allowing a new block to be validated by means of comparison with other ledgers. The mining layer provides the nodes with the incentive to perform the calculations of the consensus layer. The propagation explains the functionality of transmitting ledgers between nodes in the network. Finally, the semantic layer articulates the way in which blocks must be linked together. These four layers together will be used as the fundamental distributed ledger layer (Xiao, 2016). The working principles of this part of the technology has been published by Satoshi Nakamoto in his Bitcoin Whitepaper, which would indicate the possibility to patent the Blockchain itself has passed (Reutzel, 2016). This means that the only way in which the fundamental layer of the Blockchain technology application is patentable, is if it provides a technical solution to a technical problem that occurred in the Blockchains as published in the state of the art. This is why we have included the distributed ledger as a fundamental layer of the Blockchain technology, rather than just the Blockchain itself. Adaptations to the original technology might provide a valuable solution to a technical problem and fall within the scope of patentable subject-matter. An example of such an adaptation to the original Blockchain structure is IOTA, which has limited the scalability issues of the 'traditional' Blockchain by producing Tangle, a block-less distributed ledger. Because this invention solves the problem of increasing ledger size, it can be seen as a new, inventive solution to a technical problem, which means that there is merit for patentability. As mentioned in section 2.2.2.2, the fundamental layer of the technology will also be differentiated per the dimensions of private versus public and permissioned versus permission-less. This allows for the determination of anonymity of both users and proprietors, which should help answer the question about the infringement possibilities of a patent in the field.

The next layer is the Smart Contract, which defines the rules to which the transactions are subject, based on the Blockchain. This layer is likely not to be eligible for patenting as the code of the smart contract itself is not patentable because it constitutes a computer program 'as such', meaning there needs to be a technologically inventive step resulting from the software. The only way we might be able to protect the intellectual property rights of the Smart Contract is through copyright.

Finally, we identify the technological implications of the technology. A system using Blockchain technology that results in a technological solution to a technological problem could constitute patentable subject-matter. This strongly depends on the way in which the claims are written and what the interpretation of the law by an examiner at various patent offices will be.

On the subject of copyright, only the code is protected. This means the code both the first and the second layer can be protected by patents, the Blockchain and Smart Contracts, respectively (see Table 6).

Table 6 - Protection Possibilities of Blockchain Technology Applications

Layers / Rights	Distributed Ledger	Smart Contracts	Technical Effect
Copyright	Yes	Yes	No
Patent	Yes	No	Yes
Trademarks	No	No	No
Industrial Designs	No	No	No
Geographical Indications	No	No	No

Considering the previous few pages, we can conclude that we must consider both Copyright and Patents as protection mechanisms for the protection of intellectual property rights of Blockchain Technology Applications. This must be considered in the regions of the European Patent Office – specifically for the Netherlands, United Kingdom and Germany – the United States Patent and Trademark Office, the Korean Intellectual Property Office and the State Intellectual Property Office of the People's Republic of China. The rights that these offices can confer can be applied to the Blockchain technology application at three levels, the Distributed Ledger, the Smart Contracts and the Technical Effect.

4.2 Protection Mechanisms for Blockchain technology applications

This section aims to answer the first sub-question, after all, the protection mechanisms have been identified, along with the necessary literature to assess what protection mechanisms would suffice to protect the intellectual property of Blockchain technology applications. The answer to the first sub-question is;

> *Copyright and patents can both protect the intellectual property rights of Blockchain technology applications or Distributed Ledger technology. Copyright can protect the code and the distributed ledger, patents can protect the distributed ledger and the technical effect of the use of Blockchain technology.*

Upon closer examination of method of copyright protection, not much strategy is involved in steps to procure the right or in using it to defend technology. First of all, as soon as code is written either for the development of the distributed ledger or the smart contracts, copyright applies. Yet, only a small detail need be replaced to invalidate the copyright (WIPO, WIPO Copyright Treaty (WCT), 2018). Even the exact same code, written in another coding language, with the exact same working principles, is not subject to copyright, although this might be argued against in court. Furthermore, in litigation cases on software, copyright is not used very often as the effort to circumvent infringement of copyright on software is not

difficult. The only exception would be copyright associated with cases involving licensing agreements. But even here, copyright would hardly scratch the surface of the actual case matter. Following the Berne Convention, copyright protection only extends to expressions, not to ideas, methods, etc (WIPO, Berne Convention for the Protection of Literary and Artistic Works, 1971). This means that a different version of the same idea will not be protected under copyright anymore. Furthermore, even if copyright protection should prove useful, there is no strategy involved in obtaining the copyright, or to the method of applying it in litigation. As such, while the protection of intellectual property using copyright is possible, albeit to a limited extent, the scope of this research will be the protection of intellectual property of Blockchain technology applications using patents. As there are no strategic choices in the use of copyright, its inclusion in this research would be superfluous.

4.3 Patents

The above leaves us with patenting as the only protection mechanism. With respect to a patenting strategy, the choices can be divided over three categories; the filing route during prosecution, the part of the technology to be protected by said patent, and the formulation of said technology in said patent. The below sections will elaborate on these strategic categories and identify the choices that can be made in these categories. Firstly, the filing route can vary, from PCT application (global), to European Patent Office applications (regional) and national applications. Second, the parts of the Blockchain as described to be patented can vary. And third, the way in which the technological inventions are presented in the claims has an influence on the validity of the patent (see figure 13). The following three sections will identify the possible choices for each of these categories, and as such answer sub-question two.

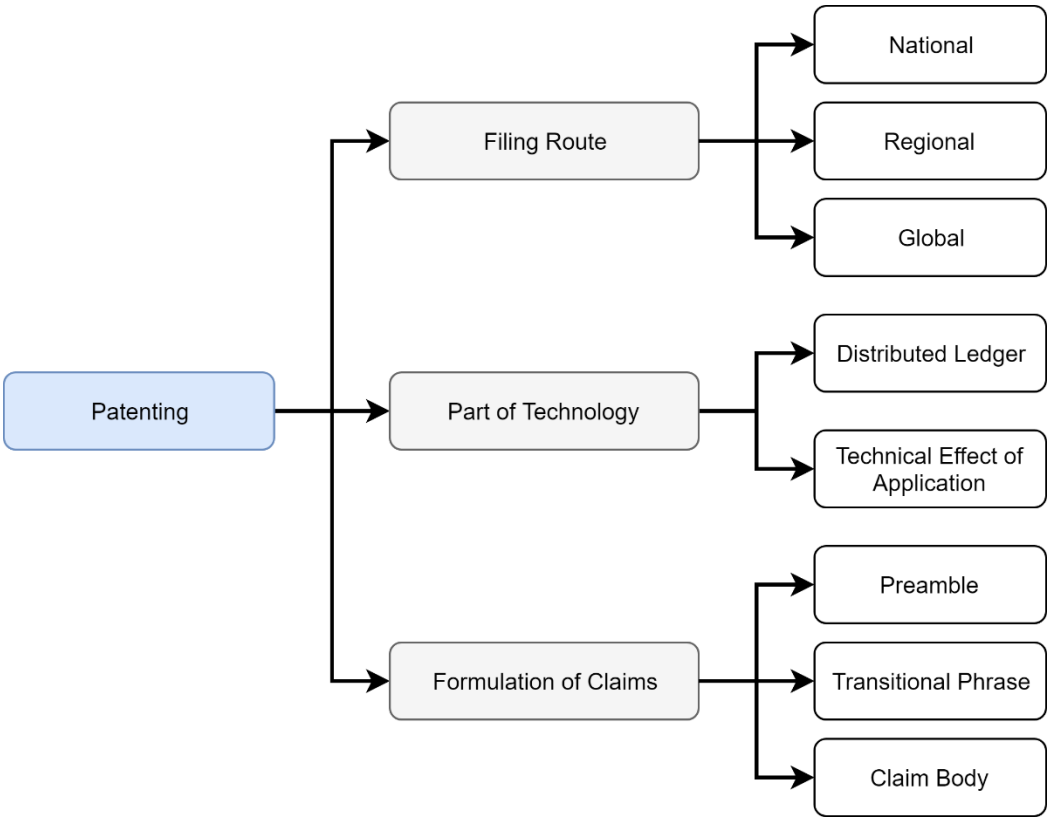

Figure 13 - Strategic Possibilities for Intellectual Property Protection of Blockchain Through Patents

4.3.1 Filing Route

The determination of the filing route will be structured according to the jurisdictional choices that can be made in a patenting process. Since the goal of a patenting process is a nationally granted patent, with possible intermediation of a regional office, the global patenting route is a variable addition to the process. First, the decision needs to be made in what jurisdictions protection is needed, based on the infringement analysis, alongside with an analysis of competition and proprietor-specific wishes. Once jurisdictional preferences have been established, the route to that filing can be determined. If the possibility exists to acquire the national patents through intermediation, the costs and benefits of this route need to be weighed, along with the possible addition of filing through the PCT procedure. Seeing as the UPC is likely not to be in effect during the period over which this research is performed, the unitary patent will not be considered in the filing route, especially considering recent changes in the member-list of the European Union.

Summarizing, following the below figure, we conclude a number of choices in the filing route. First, in which countries should there be a granted patent? This question is answered by considering strategic choices by the proprietor of the invention and will be considered an input to the decision-making framework. This first question, however, will identify the goal of the filing route, namely that of a national granted patent in all mentioned countries. The second aspect is whether intermediation of a regional office is both possible and preferred? Finally, the possibility of filing through PCT procedure is considered. This leads to four possibilities per selected country (see figure 14). Note that the green arrow denotes 'yes' and the red arrow denotes 'no'.

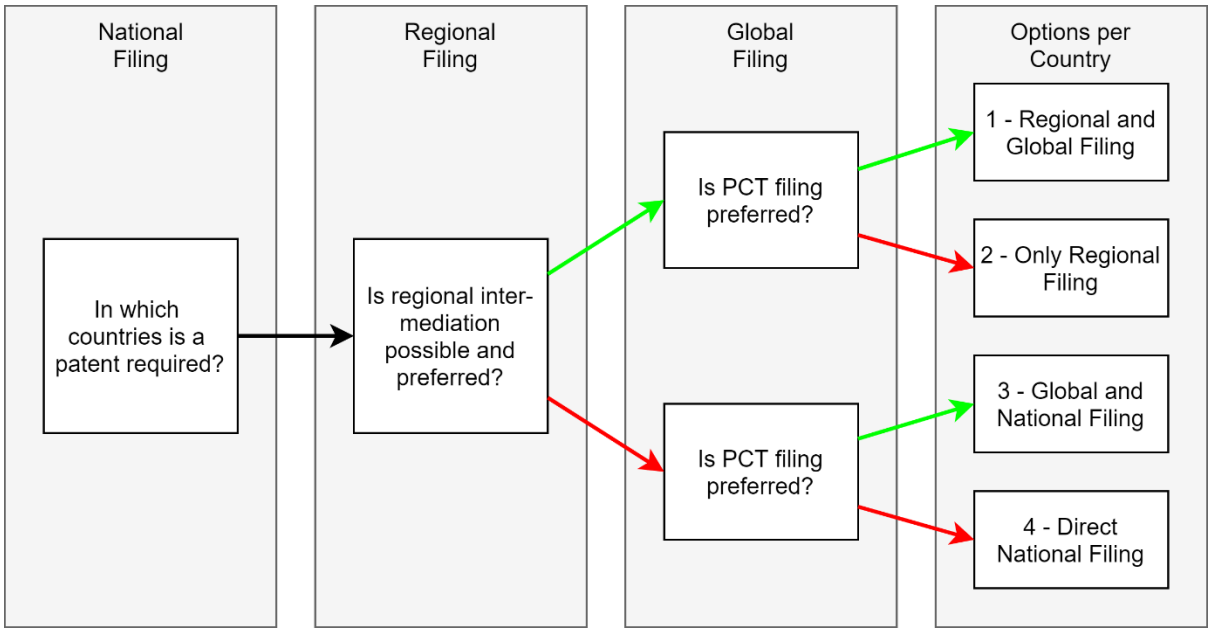

Figure 14 - Choices in Filing Route

An important additional note to the above figure is the exclusion of option three in some countries. It is not always possible to go from a PCT procedure directly into national filing without the consideration of the regional intermediation. In the Netherlands, for instance, a patent application from PCT procedure is not possible as the working principles of the search and examination as done by PCT standards does not apply to the Dutch Patent Act. Because they do not adhere to one another sufficiently, the filing procedure as described in point three will, in practice, be a direct national filing with no consideration to what was found during the earlier PCT procedure.

4.3.2 Part of Technology

The second choice concerns itself with the type of the technology that is eligible for patenting. While the underlying technicalities concerning the choices regarding the patenting of certain parts of the technology is quite complex, the choice and its result are rather simple. Of both the Distributed Ledger and the Technical Effect, the patentability and the requirements for patentability should be decided according to the law and internal preference of the proprietor. This will lead to four options, patenting both the Distributed Ledger Technology and the Technical Effect, patenting either one of them, or not patenting anything. What it is that affects these choices is more difficult to determine. Identifying the connection between these choices and the characteristics that affect them will be done in chapter 5.

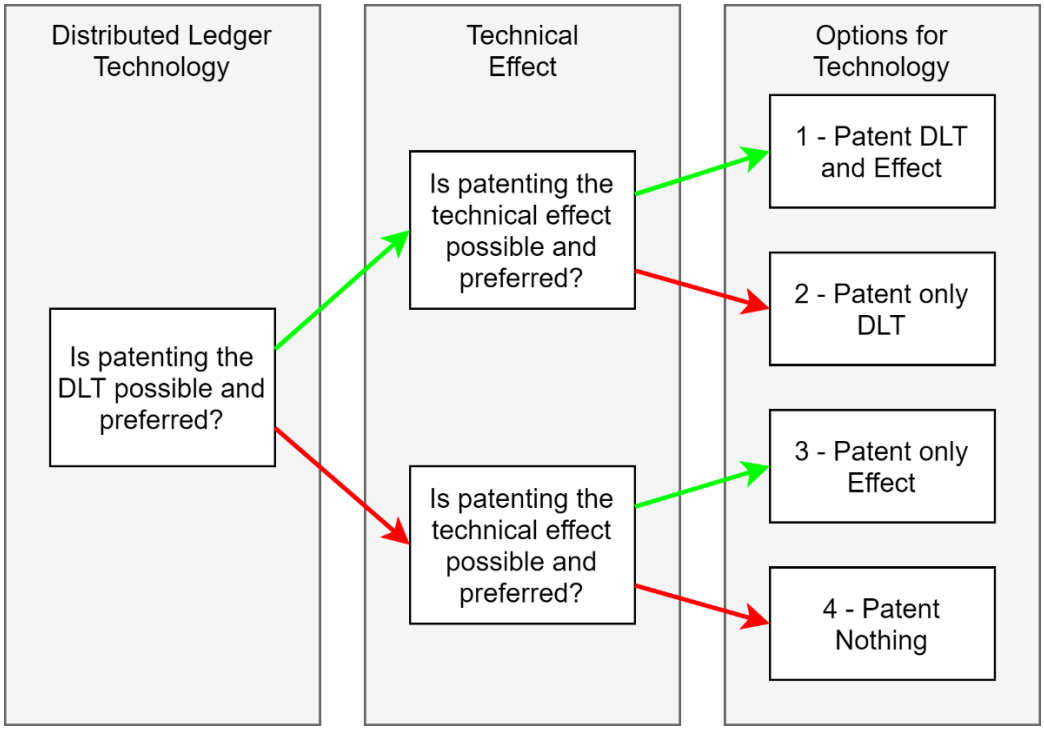

Figure 15 - Choices of Part of Technology

4.3.3 Formulation of Claims

The final set of choices that can be made in the patenting strategy concerns itself with the formulation of the claims. The previous two sections have determined the options that are available in the filing route and the technology. Now, difficulties in the formulations of the claims must be identified. As there is no specific set of options in the formulation, this section will provide a broad overview of methods in claim formulation. Literature that will be used for the analysis of the formulation of claims in Blockchain Technology Patens is presented in the below table.

Table 7 - Literature for the Formulation of Claims

Author(s)	Year	Title	Journal	Subject
Burgess, Hutt, Farokhzad, Langer, Minick & Zale	2010	On firm ground: IP protection of therapeutic nanoparticles	*Nature Biotechnology*	Regulatory difficulties of new technology development
Burk & Lemley	2009	Fence Posts or Sign Posts? Rethinking Patent Claim Construction	*University of Pennsylvania Law Review*	Indeterminism of Claim Construction
Hodes	2005	Competitive Product Intelligence system and method, including patent analysis and formulation using one or more ontologies	*N/A (Patent Application)*	Patent claim analysis method and claim background
Matutes, Regibeau & Rockett	1996	Optimal Patent Design and the Diffusion of Innovations	*The RAND Journal of Economics*	Influence of patent construction on innovation
Robinson	2015	Patent Law Challenges for the Internet of Things	*Wake Forest Journal of Business and Intellectual Property Law*	Look on infringement based on claim drafting on IoT Applications
Schwartz	2009	Courting Specialization: An Empirical Study of Claim Construction Comparing Patent Litigation Before Federal District Courts and the International Trade Commission	*William & Mary Law Review*	Interpretation of claims by a court of law
Sheremetyeva	2003	Natural Language Analysis of Patent Claims	*Association for Computational Linguistics*	Method for Neuro-linguistic programming for analysis patent claims.

First, the function of claims will be explained, after which type of claims will be elaborated on, with the inclusion of claim form for admissibility. Finally, the reasoning behind certain considerations in the patenting process regarding the development of covering claims will be discussed.

4.3.3.1 Claim Structure

A set of claims define the invention for which protection is sought, which in emerging technology can be a complex process given the volatile nature of regulatory bodies with respect to these claims (Burgess, et al., 2010). They are a series of statements, that define the invention and establish the scope of protection of a patent (White, 2018). Both points are very important to consider as they do not necessarily cover the same concept but are aimed at capturing both functions in one statement. The claims in a patent describe what the inventor is being protected from by allowing the inventor an exclusive right, as described earlier. What that exclusive right entails follows from the claims. However, one might consider that an inventor is not eagerly inclined to divulge his ground-breaking invention if the protection is very specific and narrow, only protecting his invention and no other interpretation of the technology. A competitive party could simply alter one detail and escape from infringement litigation. So, the scope of protection of a patent, as put forward by the claims, is usually much wider than the actual invention. As one might imagine, the scope of protection sought by the inventor and the patent attorney working for said inventor is as wide as possible, while the patent offices around the world aim their efforts at making sure the sought protection does not get too big. It is exactly this reasoning that puts patent attorneys and patent office examiners head to head in conflicts over the scope of patent protection during prosecution activities on behalf of inventors.

There is a number of characteristics based on which the nature of a claim may be defined. First, the existence of *dependent* and *independent* claims is very important. The independent claim in a patent, which is usually the first claim in a patent, is characterised by being *self-contained*. This means that the claim can be read and understood by itself and does not bear any relationship to other claims in the determination of its validity (EPO Guidelines, 2018). Also, a set of claims must contain at least one independent claim, which is the foundation of the to be claimed subject-matter. The dependent claim, on the other hand, is to be read in combination with an independent claim. For instance, the independent claim might read *"An apparatus comprising A, B, and C."* and the dependent claim might read *"The apparatus of Claim 1, wherein the apparatus comprises D"*. It is clear that the dependent claim cannot be read without consideration of the independent claim. Generally, the dependent claims are aimed at extending the protection of a patent by including several types in which the subject-matter of the independent claim can be constructed.

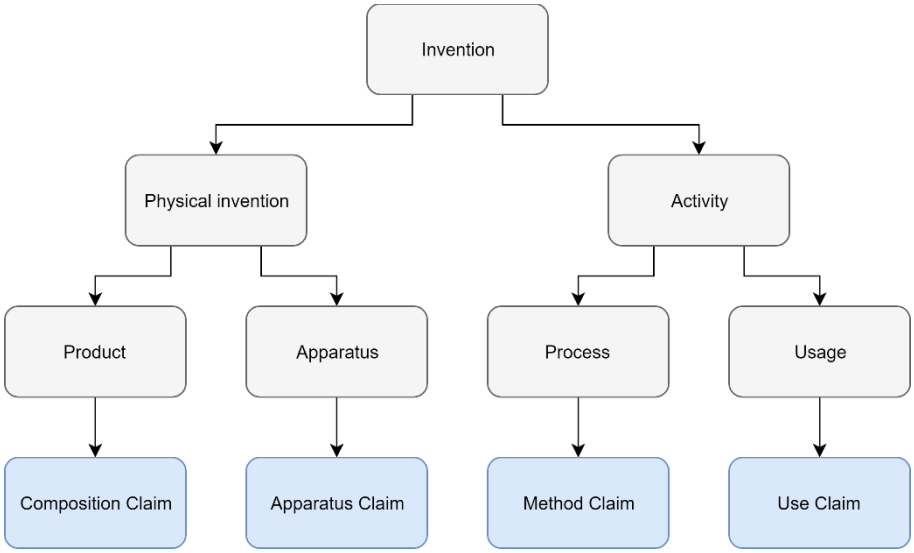

Figure 16 - Most Common Claim-Types (adapted from (Jelsch, 2018))

Now that we have identified the difference between the independent and the dependent claims, a consideration can be made on the different types of independent, and by extension the dependent claims. An invention can be characterized through various types of claims, as shown in the figure above. While some types are excluded, the figure encompasses the most used types of claims.

Apart from the above claim types, there are some other types that are less common, but for the scope of this research, are worth mentioning. Generally, the two claim types that are most common are method claims and apparatus claims, these can be used to cover almost all other types of claims (e.g. *a method for X comprising the use of…)*. Use claims can be relevant but are not allowed in all jurisdictions, the United States being a notable example. Product-by-Process claims are a combination of method and product claims wherein the product is obtained through the application of the method. Finally, software claims generally use method or apparatus claims to define the scope of protection for a computer-related invention (see section 6.2.3). They are often mentioned separately but generally comprise of either a method, apparatus, or product-by-process claim.

From the above, we can conclude that a patent attorney first drafts an independent claim, in which the decision of the type of claim should be made, dependent on the type of invention. Drivers for these choices are not fully defined as the subject-matter of the invention becomes slightly opaque. As shown in the above example of software claims, which can essentially be any type of claim, dependent on what would suit the invention best. If the invention pertains to a technical effect, the independent claim is likely to be a method claim, while when the structure of the system the software comprises is fundamentally different, one might use a product claim in the form of *"A system comprising…"*. The drivers and subsequent choices of the types of claims will be discussed in the next chapter. Research into the claims of granted patens over the period of 2005 – 2014 in the United States shows the predominant preambles of independent patent claims consist of *"a method"*, *"An apparatus"*, and *"A system"*, followed – but not closely – by *"A semiconductor device"*, *"An image forming apparatus"*, and *"A device"*, see the below table for the first 15 entries of the research (Crouch, 2014). Notably, in the below table, when compared to the types as described in figure 16, some of the preambles fall under comparable claim-types so as to reinforce the differentiation (e.g. *A device*, *An apparatus*, *A display device*, *An electronic device*, etc.).

Table 8 - Preambles of US Patents 2005-2014 (adapted from Crouch, 2014)

Rank	Preamble	Count
1	A method	111124
2	An apparatus	64954
3	A system	57933
4	A semiconductor device	25371
5	An image forming apparatus	15317
6	A device	13064
7	A computer program product	12947
8	A computer system	10564
9	A composition	9140
10	An integrated circuit	8469
11	A computer-implemented method	8017
12	A display device	8001
13	An electronic device	7843
14	An article	5789
15	An article of manufacture	5660

The characteristics that have been discussed so far refer to the type of the claim, rather than the contents. A claim is constructed by the combination of a *Preamble*, a *Transitional Phrase*, and a *body*. These components should confer the scope of the invention. The preambles have been touched upon in the above section, they tell the category of the invention, and may recite an object of the invention. For instance, the preamble may state *"A method for X"* or *"An apparatus for Y"*. The transitional phrase of the claim can be either open-ended or closed. What is meant by open-ended versus closed pertains on the level of inclusion of the characteristics that are mentioned after the transitional phrase. An open-ended phrase does not exclude characteristics of the invention that are undisclosed in the claim following the transitional phrase. A closed transitional phrase does just that, it stipulates exactly the characteristics of a claim, thereby limiting all possibilities to another embodiment apart from that claim. In practice, closed transitional phrases are tended to be avoided. Nevertheless, for very specific patent applications, the use of a closed transitional phrase might add to the clarity of the subject-matter to be patented and as such offer more stringent protection.

Finally, the body of a claim determines what should be patented by reciting the limitations to which the preamble is subject so as to fall outside of the prior art. This is done by characterising certain parts of the invention with relation to the preamble or to one another, leading back to the preamble. The result of this requirement is that no one characteristic in a dependent or independent claim stands on its own without reference to the preamble of the claim. In practice, on determines what the subject of the invention is, and identifies the preamble, after which the characteristics necessary to have the invention deviate from the state of the art are added. Once the independent claim has been constructed, the dependent claims refer to different embodiments of the independent claim or other dependent claims so as to cover additional features in the invention that are not specifically covered by the independent claim. The construct of the body is dependent on a number of influencing factors, most notably the prior art and the embodiment of the claim (United States of America Patentnr. US2005023478A1, 2005).

It should be noted that any dependent claim features the same structure as an independent claim by referring to said independent claim. However, by itself, the dependent claim does not have to constitute patentable material, it must be considered in relation to the independent claim. We can therefore conclude to the following figure, wherein the dependence of the claim is determined by the width of the patentable material, which should be as unrestricted as possible. Note that the figure (figure 17) incorporates the above figure as adapted from Jelsch (figure 16), as the type of claim is identified through the preamble.

Also, although the body does not state the dependence of the claim, it determines the dependence of the claim as a claim is only necessarily independent if the characteristics in the claim are features that distinguish the invention from prior art. As such, the characteristics of the invention in relation to prior art, as depicted in the body of a claim, should determine the dependence of said claim. The below figure concludes the generic reasoning of an individual claim. The following paragraphs will identify additional features to be held in consideration for the purposes of claim formulation.

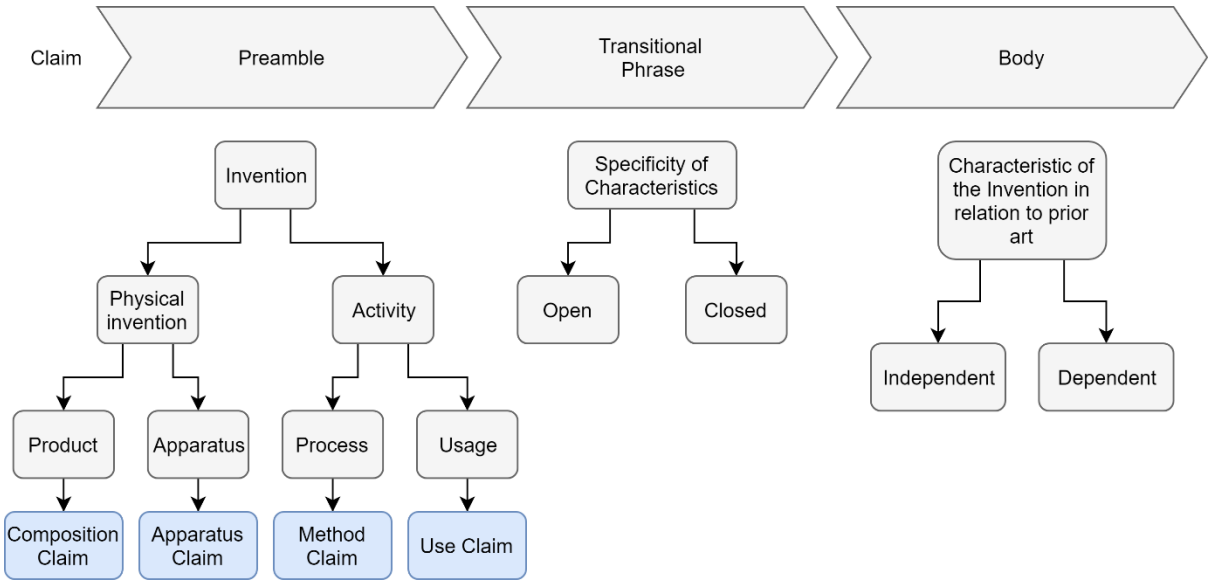

Figure 17 - Claim Structure

4.3.3.2 Claims in Patents

Most patents have more than one claim, which means a patent attorney and the inventor need to take into consideration what the optimal breadth and number of claims are. In some cases, this consideration has led to an extraordinary high number of claims, or just one. Also, a consideration of the complexity and the language in a patent claim can add to the optimal formulation of a patent. Generally, the language in patent claims is quite complex and encompasses very long sentences (Sheremetyeva, 2003), partly because of the restriction that a patent can only entail a single sentence. Claim construction is often acclaimed to be indeterministic just for that reason (Burk & Lemley, 2009). It requires both a legal and a technical view of the to be patented material and the proprietor always tries to get a granted patent encompassing as much as possible rather than exactly the amount to which the inventor has a right (Schwartz, 2008). So, what are the choices in claim construction that a patent attorney can make, based on the invention of the proprietor? Arguably, the exact number of the claims is not what is deterministic for the success of a patent in either prosecution or litigation, rather the scope of the patentable material is the driver for the determination of validity of the patent, to which both prosecution and litigation aim to provide an insight (Matutes, Regibeau, & Rockett, 1996). Essentially, this entails that the scope with which protection is sought for the invention should be determined by the patent attorney based on the prior art and the embodiments of the invention. The choices can be categorized into two aspects, the development of the independent claim and the dependent claim.

The independent claim should be constructed based on what the prior art allows in which the embodiment of the invention should be kept as broad as possible. After the independent claim has been formulated, the dependent claims can add to the independent claim in specific embodiments that enlarge the scope of protection from the independent claim. The choice the patent attorney has, based on the invention that is presented to him, is what features to use for the independent claim and what to use for the dependent claim, without risking a non-unity objection or clarity objections on the one hand and criticism of the inventor for a limited scope on the other hand.

In addition to this, the shared nature of the subject-matter in a patent application on Blockchain technology leads to possible infringement by multiple actors. Usually, the possibility to infringe as a third party is limited by provisions in a patent, however, joint infringement is a possibility that a patent attorney should consider a possibility (Robinson, 2015). Especially under United States Case Law, this possibility needs to be accounted for (Akamai Techs., Inc. v. Limelight Netowrks, Inc. , 2014). Patent attorneys therefore should try to avoid joint infringement problems by drafting claims in an actor-specific way.

4.4 Summary of Protection Strategies

This chapter aimed to provide an overview of the possible protection strategies and the choices within those strategies in the protection of the intellectual property Blockchain technology applications. To classify the protection strategies, the subject-matter of the inventions to be protected were determined. Blockchain technology has been divided into three parts for the present research; the distributed ledger, the smart contracts, and the technical effect of the application of Blockchain technology. Following the discussion on intellectual property law based on literature in chapter 2, the only two intellectual property rights equipped to protect intellectual property relating to Blockchain technology are patents and copyright, thereby answering the first sub-question as proposed in section 1.3.2.

Patents have the possibility to protect the distributed ledger and the technical effect of the application, while copyright can protect the (code of the) distributed ledger and the smart contracts. As copyright does not involve any strategy, once the work has been produced, the scope of this research will be limited to patents. In answering sub-question 2, only patents will therefore be considered.

Considering patens, strategies can be defined in the filing route during prosecution proceedings, the type of the technology that is protected by the patent and the formulation of the claims protecting said invention. During prosecution, the filing route holds three possibilities; global and regional filing, only regional filing, or direct national filing. All these strategies can be combined with a priority document from either three possibilities. The patentable part of the technology holds four options, patent the distributed ledger and the technical effect, patent the distributed ledger, patent the technical effect, or patent nothing. The formulation of the claims can be divided into three parts, the development of the preamble, the transitional phrase, and the body. The most common preambles are product, apparatus, process, or usage claims, as shown in figure 16. The transitional phrase can be either open or closed. The body of a claim can be either dependent or independent, based on the characteristics of the invention as provided in the state of the art. In addition to the above considerations of claim formulation of individual claims, the totality of claims in a patent can be considered as well. Based on literature and the law, however, the number of claims is not deterministic for the success of a patent in litigation or prosecution. Rather, the scope of the matter to be patented is deterministic for said success (i.e. the body of a claim). The subjective nature of the matter to be patented is a barrier for inclusion in a decision-making framework but a methodology has been determined nonetheless (see section 5.3.3). This paragraph answers the second sub-question and are captured by the combination of figures 14, 15 and 17.

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5 Theoretical Decision-Making Framework

"Some people wish above all to conform to the rules, I wish only to render what I can hear. There is no theory. You have only to listen. Pleasure is the law."

– Achille-Claude Debussy –

To create a theoretical decision-making framework from the aforementioned, the relationship between characteristics of the technology of the proprietor and the choices need to be analysed. To do this, literature will be reviewed regarding separate relationships. A review of this literature will allow the development of a theoretical decision-making framework, which will be validated in chapters 6. The characteristics of the proprietor will be analysed so as to determine what exactly affects the choices as mentioned in chapter four. This will be done by first analysing the filing route, followed by which part of the technology should be patented and finally how these inventions should be claimed in a patent application. As these characteristics have been identified, their influence on the choices will be determined.

5.1 Filing Route

The first part of the patenting strategy that will be considered is the filing strategy. The choices that a proprietor, in collaboration with the patent attorney, can make regarding the filing strategy can be categorized into the beforementioned structures of National, Regional or Global filing procedures. These choices depend on various indicators, which will be identified in this chapter. These indicators point towards the best way of getting patent protection for the invention of the proprietor, the first of which is jurisdictional preference, of which the complex issue of infringement of intellectual property rights in the field of Blockchain Technology is a part. Next, risk will be considered along exposure of money and of time. Different preferences concerning the ability to incur risk will lead to other choices in the filing procedure. Finally, competition will be discussed, including the activity of competitors in the field in which the proprietor operates and the need for fast litigation.

5.1.1 Jurisdictional Effects on Filing Route

The proprietor usually has an idea about the countries in which protection is needed, based on his wishes of distribution of the invention. The determination of the countries in which a proprietor wishes to obtain protection for the intellectual property rights will play an influential role in the choice of filing route. For example, if the only country the proprietor needs protection is South Africa, the best choice of action might be to directly file for patent protection in South Africa. If, however, the choice of country is the Netherlands, it might be more beneficial to file for patent protection through the EPC, with the possible addition of a PCT procedure on beforehand.

To determine where a proprietor requires a patent application, it is important to know what the effects of holding such a patent are. This boils down to the following question; what happens with a granted patent in infringement litigation? Traditionally, an inventor files for patent protection for an invention that he aims to use or sell. He files for patent protection in the countries that he expects to make money with his product and where he wants to limit other parties to use his idea. Let's assume a Dutch scientist developed a product that he aims to sell in the Netherlands and Germany, but which might also have a market in France. The scientist can then file for patent protection in those countries and cover his entire potential market. He will sell his product in the Netherlands, export to Germany and he can license the development of his product to another manufacturer in France. All other countries are not part of his market, so he has full control over his market.

Now imagine that the same scientist develops an invention that is based on Blockchain, let's say a product provenance system. This product can be used by many companies around the world, so the market is quite large. And because there is no central server, on which data is stored, determining in what countries

filing for patent protection will have the largest effect is very difficult. Suppose we have patent protection in the same three countries, the Netherlands, Germany, and France. A competitor has developed the same system in the Netherlands but sells access to the system to clients in the United Kingdom, is he infringing your patent? Another competitor develops the same invention in Belgium, where he holds a patent, and provides the service to clients he has in Germany, is he infringing your patent? The third competitor is developing in the Netherlands and selling in Germany, so he must be infringing, but what is he infringing, the Dutch patent or the German patent?

This problem becomes even larger as the user base becomes openly accessible. If any person in the world has access to the system that the proprietor has developed, determining who is infringing, and what they are infringing becomes an arduous task. If such a system were to be developed by our Dutch scientist and a Belgian user, over which the inventor has no control, makes use of the product in Belgium, who is infringing the aforementioned Belgian patent, held by the second competitor? Can the Dutch scientist be held accountable for allowing the Belgian user to access his system, or is the user the party who is infringing? To determine, in various scenarios, who is the infringing party, which will lead to considerations regarding the filing procedure, the law will be analysed regarding Blockchain technology and where not conclusive, analogies with similar subject-matter will be made, which allows us to review case law relevant to other technologies.

To determine what the effects of a patent in the case of litigation will be, the law will be reviewed, over the jurisdictions as previously discussed. Following the WIPO Intellectual Property Handbook, the grant of a patent confers to its proprietor the exclusive right to the exploitation of the invention. Practically, this entails that a patent ensures that others may not, by law, make, use, distribute, import, or sell, in a commercial fashion, the invention as described in the claims of the patent, without consent of the owner of the patent. This exclusive right means that the initiator of any form of litigation should be the proprietor of the patent. The enforcement of the exclusive rights conferred by patents, as mentioned above, depend on the level of commercial applicability of the actions by another party. We will categorize the infringing parties in 1) producers and 2) users, both of which could infringe a patent.

Considering patent infringement, a proprietor can start a litigation procedure if he recognizes a party partaking in a so-called Prohibited Act. Following the WIPO Intellectual Property Handbook (page 30, section 2.99): *"A prohibited act, the most important element in establishing an infringement, is on which involves the making, using, selling or importing the patented product, or the use of the patented process, or the making, using, selling, or importing the product directly obtained through the patented process."* (WIPO, WIPO Intellectual Property Handbook, 2004). From the basis of the law, it seems the theoretical background of infringement litigation is quite simple. If you want to stop someone using, producing, or otherwise exploiting your invention for commercial gain, simply make sure you have a patent in the selected country. As mentioned, open access systems make the situation slightly more complex, but the law remains the same. If any user or producer of a product infringes on the basis of the above, there are grounds for litigation.

The jurisdictions as discussed in the earlier section are all a part of the WIPO and are likely to follow the same basis for litigation on the basis of prohibited acts. Following the US Code (35 USC 154, Contents and term of paten; provisional rights), a US patent confers to its proprietor *"the right to exclude others from making, using, offering for sale, or selling the invention throughout the United States or importing the invention into the United States, and, if the invention is a process, of the right to exclude others from using, offering for sale or selling throughout the United States, or importing into the United States, products made by that process, referring to the specification for the particulars thereof."* (USC, 2018). The implications of the United States law then, are similar to that of the WIPO.

The Patent Act of the Republic of Korea states that *"A patentee shall have the exclusive right to work a patented invention both commercially and industrially."* under chapter 5, Article 94, Effects of patent

Right (KIPO, 2001). The term 'to work' is more substantially conferred by Article 127 in Chapter 6, Acts Deemed to be Infringement: *"The following acts shall be deemed to be infringements on a patent right or an exclusive license: (i) in the case of an invention of a product, acts of making, assigning, leasing, importing, or offering for assignment or lease articles used exclusively for producing such products; and (ii) in the case of an invention of process, acts of making, assigning, leasing, importing or, offering for assignment or lease articles used exclusively for working such a process."* At first glance it seems that the above description of infringing acts excludes commercial use as a reason for litigation. However, as described in the definitions of the Korean Patent Act, the term 'working' includes *"acts of manufacturing, using, assigning, leasing, importing, or offering for assigning or leasing the product"*. As such, the Korean Patent Act follows the line of reasoning as set forth by the WIPO.

In the Law of the People's Republic of China, Article 11 states the following: *"After the patent right is granted for an invention or a utility model, unless otherwise provided for in this Law, no unit or individual may exploit the patent without permission of the patentee, i.e., it or he may not, for production or business purposes, manufacture, use, offer to sell, or import the patented products, use the patented method, or use, offer to sell, or import the products that are developed directly through the use of the patented method."*, which has a similar limitations on the infringement possibilities as the WIPO (SIPO, 2008).

The European Patent Office has a different method of defining the prohibited acts as described by WIPO. In part 2, chapter 3, Article 64 (1) of the European Patent Convention, Rights conferred by a European patent are *"in each Contracting State in respect of which it is granted, the same rights as would be conferred by a national patent granted in that State."* (EPC, Article 64 - Rights conferred by a European patent, 2016). This means that for each of the relevant contracting states there is a need to review national law for the purposes of litigation as under the same chapter, Article 64 (3) states that *"Any infringement of a European patent shall be dealt with by national law."*, which points towards the national law of the Netherlands, Germany and the United Kingdom as pointed out in chapter 3 of this report.

The Dutch Patent Office offers patents subject to the Dutch Patent Act. In this Act, under Chapter 4, paragraph 1, Article 53 (1), the right that a patent shall confer onto its owner is an exclusive right to *"to make, use, put on the market or resell, hire out or deliver the patented product, or otherwise deal in it in or for his business, or to offer, import or stock it for any of those purposes"* (DPO, 2009).

In The Patents Act of 1977, the Intellectual Property Office of the United Kingdom states that infringement constitutes the following: *"where the invention is a product, he makes, disposes of, offers to dispose of, uses or imports the product or keeps is whether for disposal or otherwise"* and *"where the invention is a process, he uses the process or he offers it for use in the United Kingdom when he knows, or it is obvious to a reasonable person in the circumstances, that its use there without the consent of the proprietor would be an infringement of the patent"* (IPO, 2017). As with the above laws, this also applies to products obtained through the above described method for which a patent has been granted.

Finally, the German Patent Act states that *"The patent shall have the effect that the proprietor of the patent alone shall be entitled to use the patented invention within the scope of the law in force. In the absence of the consent of the proprietor of the patent, any third party shall be prohibited from 1. Producing, offering, putting on the market or using a product which is the subject-matter of the patent, or from either importing or possessing such a product for the purposes referred to; 2. Using a process which is the subject-matter of the patent or, if the third party knows or if it is obvious from the circumstances that use of the process is prohibited in the absence of the consent of the proprietor of the patent, from offering the process for use within the territorial scope if this Act"* (Patentgesetz, 2013).

Concluding from the above, we can state that the patent acts of the Netherlands, United Kingdom and Germany convey a similar message concerning the scope of protection of patented subject-matter. By extension, considering these jurisdictions, the European Patent Convention does the same. In accordance with the World Intellectual Property Organization, we can identify two groups of possibly infringing parties

across the jurisdictions as discussed above; commercially inclined users and producers, which, per the explanation of the Blockchain Technologies points towards private, permissioned systems as having the highest likelihood of infringement as they are often aimed at commercial application of the technology.

Per the aforementioned, the conclusion can be drawn that following the law, the infringement of intellectual property rights of Blockchain patents is relatively straightforward over the discussed jurisdictions. Making or using the patented subject-matter commercially, would lead to infringement possibilities according to the law. Difficulties will likely arise as the burden of proof is complex with a decentralized system such as Blockchain. Theoretically however, as is the purpose of this section, the exclusion of production or commercial use of the technology can be jurisdictionally done through a patent in the country where this specific protection is sought. Beyond this, proprietor-specific considerations will determine the choice of filing route as far as jurisdictions go, the choice of who to aim the patent protection at, specific producers or users, is dependent of the market in which the proprietor operates.

5.1.2 Risk

Another aspect that plays a role in the choice of optimal filing strategy is risk. To discuss this topic, we will regard two separate factors, time and money. As some procedures in the filing process are more time consuming or costlier, the differences between the most predominant filing strategies will be highlighted below. An important note when considering the below is the fact that the numbers represent estimations of the total time and money that various filing procedures will cost. The proprietor-specific consideration of when this money needs to be paid and what the advantages and disadvantages of the time-scale are, are for the proprietor to determine. For example, if the proprietor needs a quick grant, to start litigation or licencing activities, there might exist an inclination towards a shorter time-scale, even when this is more expensive. On the other hand, spreading out costs over a very long granting procedure might be more beneficial for firms looking for investments as the period over which they have the possibility to extend the attempts to raise funds is longer. Examples of this will be given below, in response to the costs and filing periods of the filing routes to be discussed.

Three generic filing routes will be considered as they cover the vast majority of combinations surrounding the above jurisdictions. In ascending order of complexity, we will analyse the costs and time of a patent of 1) direct national filing, in which we will consider all of the jurisdictions mentioned in section 2.1.5, 2) regional filing, followed by national grants in all of the above jurisdictions, where applicable, and 3) global filing, followed by regional filing, followed by national grants. As the costs involved in the process of filing patents are highly adaptive to the subject-matter, region and the fees of patent attorneys, the costs that are involved in the above filing strategies are an estimate, based on the costs of the various patent offices. The data was gathered by the Netherlands Enterprise Agency and the Benelux Office for Intellectual Property (Octrooicentrum Nederland, 2018). Notably, in this overview, per the above argumentation, the costs of patent attorneys are not included, nor are the costs for translation or additional fees based on the subject-matter of the claims. These costs are, when compared to information on the current costs of patent offices, very low and would only be realistic in the unlikely event that the patent is so completely simple that there would be no need at all for the involvement of a patent attorney. However, the data do show, quite exemplary, the differences between the countries in various phases of filing and are proportionally in line with the payments that would be required to get a patent granted including the extra costs as mentioned above.

The first filing procedure, that of direct national filing entails a direct procedure with a national patent office, including all fees involved with such procedures. The distinction has been made in Filing Fees, Search Fees, Examination Fees, Grant Fees and Renewal Fees. These are all to be paid to the patent office that handles the application or the granted patent. In the figures below, it is clear that the renewal fees, rise each year, this is to discourage the unproductive allocation of intellectual capital to one legal entity (Whitney, 1919). The patent holder should be encouraged to allow use of his patented invention as soon

as possible, which is why the patent fees are only sustainable in a large jurisdictional field if the invention is very profitable or has large strategic advantages. These costs are essentially an anti-shelving measure. Note that in the below figures, the costs from year 5 are the same over all filing routes. This is because, as mentioned above, the costs of renewal fees are the same over the whole period of a patent's lifetime because these are being handled by national patent offices, irrespective of the way in which they have been filed. As was probably noted already, the below figures have two peaks as a result of the payments to the USPTO. These are to be paid only in year 8 and 12 and could influence decisions for the proprietor regarding spending pattern. This is dependent on the preferences of the proprietor.

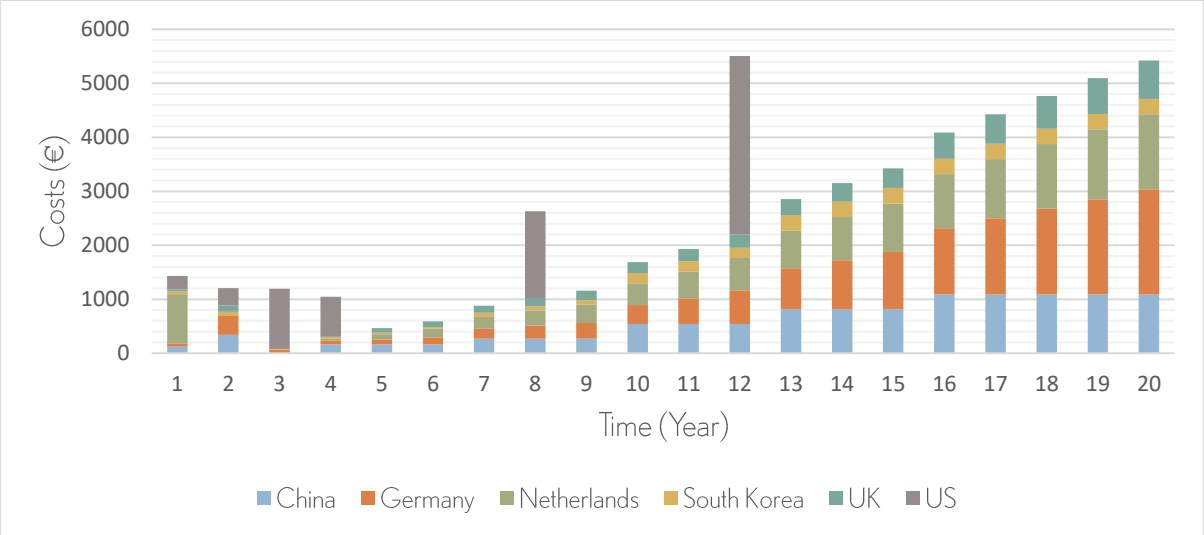

Figure 18 – National Route – Jurisdictional Costs over Time (Source: Octrooicentrum Nederland)

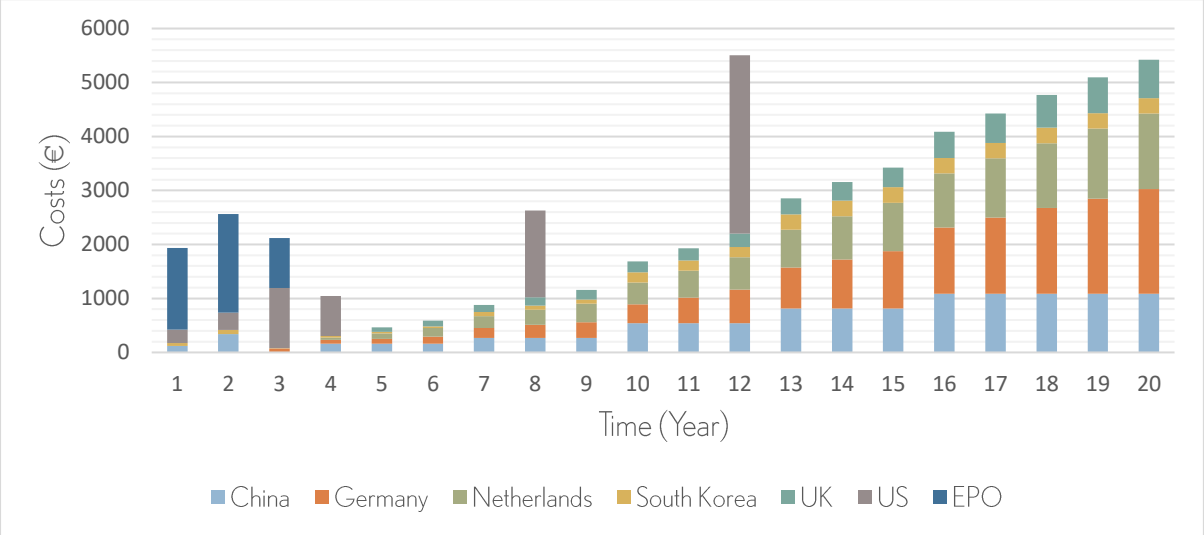

Figure 19 – Regional Route – Jurisdictional Costs over Time (Source: Octrooicentrum Nederland)

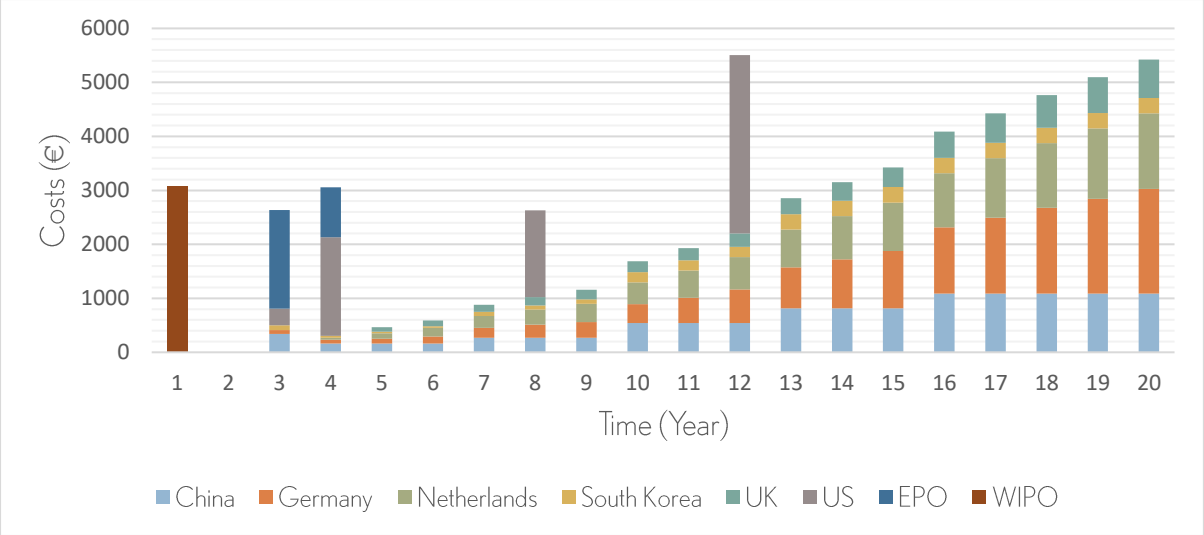

Figure 20 – Global Route – Jurisdictional Costs over Time (Source: Octrooicentrum Nederland)

As can be seen, there is a notable difference in the first four years of the filing procedure with respect to the fees that apply to the proprietor. In figure 19, the costs of the EPO are clearly higher than they would have been in national filing. However, the costs of the EPO filing procedure do not rise as the number of national filings rise. We have considered only the Netherlands, Germany, and the United Kingdom in our analysis as they would be most relevant to the protection of intellectual property rights for Blockchain technology applications. Furthermore, the global filing route, using the PCT procedure, has a higher filing fee but allows for later entrance into the national phase, thereby limiting the costs in the second year, as shown below (figure 21).

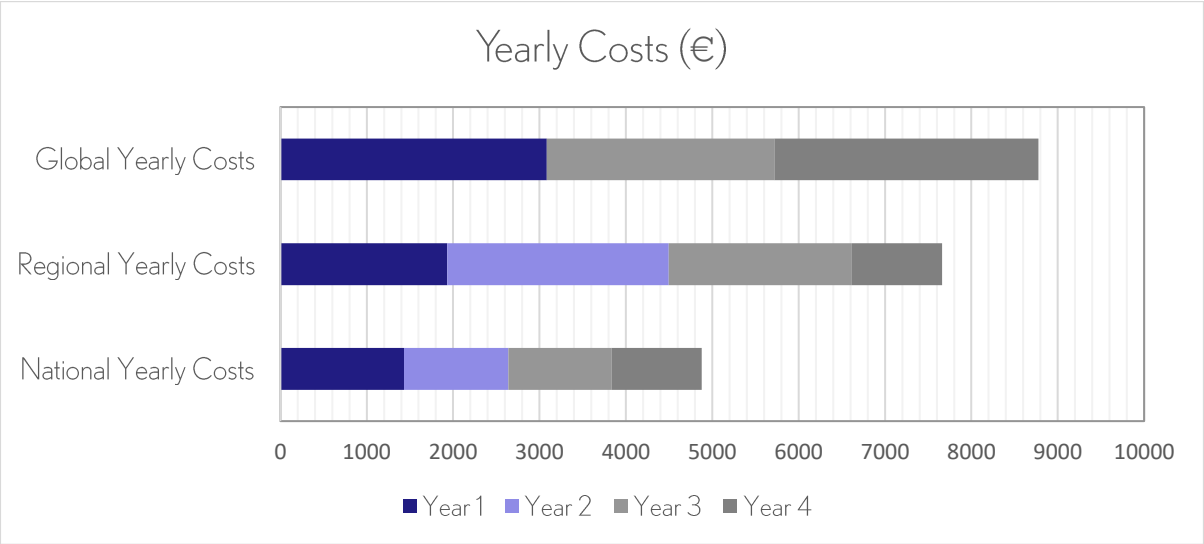

Figure 21 - Yearly Costs Over First Four Years (Source: Octrooicentrum Nederland)

With reference to time, two different routes can be considered, the Paris route or the PCT route. Considering only PCT-affiliated countries, which covers almost all countries in the world, a proprietor has the option of filing through PCT or the combination of National or Regional offices. With respect to timeline, the difference between those filing routes is the additional time the proprietor gets before starting the National or Regional filing phase, namely eighteen months. The reason for this difference is the difference between the time to national filing from PCT and the possible extension of national filing based on the right to priority. The latest application possibility during PCT is thirty months after filing, the latest possible claim to priority is twelve months, hence the advantage of eighteen months in PCT. If the proprietor is in need

of a fast grant, the PCT procedure might still be useful but must be preceded by a quick national application on which priority is invoked. The choices of filing route based on risk then, is to a large extend based on two things: 1) The need for a granted patent (time) and 2) the wealth of the proprietor (money).

5.1.3 Competition

Finally, the consideration of competition will round up the discussion on the filing route. As a patent is fundamentally a tool to limit competitive infringement, an analysis of the level of competition in a particular field is important so as to determine the level of importance of a certain jurisdictional protection (Harrigan & DiGuardo, 2017). After all, whether the goal of the patent is to block the activity of a competitor in the field, or the goal is to limit the use of the invention by a commercial user base, in both cases competition is being hampered. The level of competition then, could indicate the worth of the patent in that area. It could also influence the time-sensitivity of the granted patent in an area due to need for litigation or need for licensing in a certain area. The level of competition in a particular field in which the proprietor seeks protection then, is to be included as a supplementary indicator on the jurisdictional preference, considering the involved risk.

5.1.4 Framework for Filing Route

The theoretical decision-making framework with respect to the filing route can now be constructed. As shown in the below figure, the first point of determination is based on section 5.1.1, jurisdictional preference. Once a list of countries in which patent protection is sought has been established, the framework splits the determination in general preference regarding time versus country-specific time preference. If in a select number of countries fast protection is necessary, priority could be invoked before going into another type of filing. Regarding overall time-to-grant preference, as explained in section 5.1.2, company specific preferences of the proprietor over the whole portfolio of patents can influence the optimal filing route. Regarding monetary considerations, the framework depicts another section, namely that of the preference for early cost reduction, which could change the filing route as chosen in the first section of the framework. If the proprietor has a preference for cost reduction in early stages of the patenting process, the number and spread of the countries in which patent protection is sought will determine how the optimal filing route changes. If the countries in which the proprietor seeks protection are all in one region and are abundant to the extent that a regional filing is cheaper than individual filings per country, logically, the preferred route would be regional filing. However, if the earlier part of the framework has determined that a national filing route is optimal due to high pressure to get all patents granted in the portfolio, the trade-off between the monetary or time-based considerations are for the proprietor to evaluate.

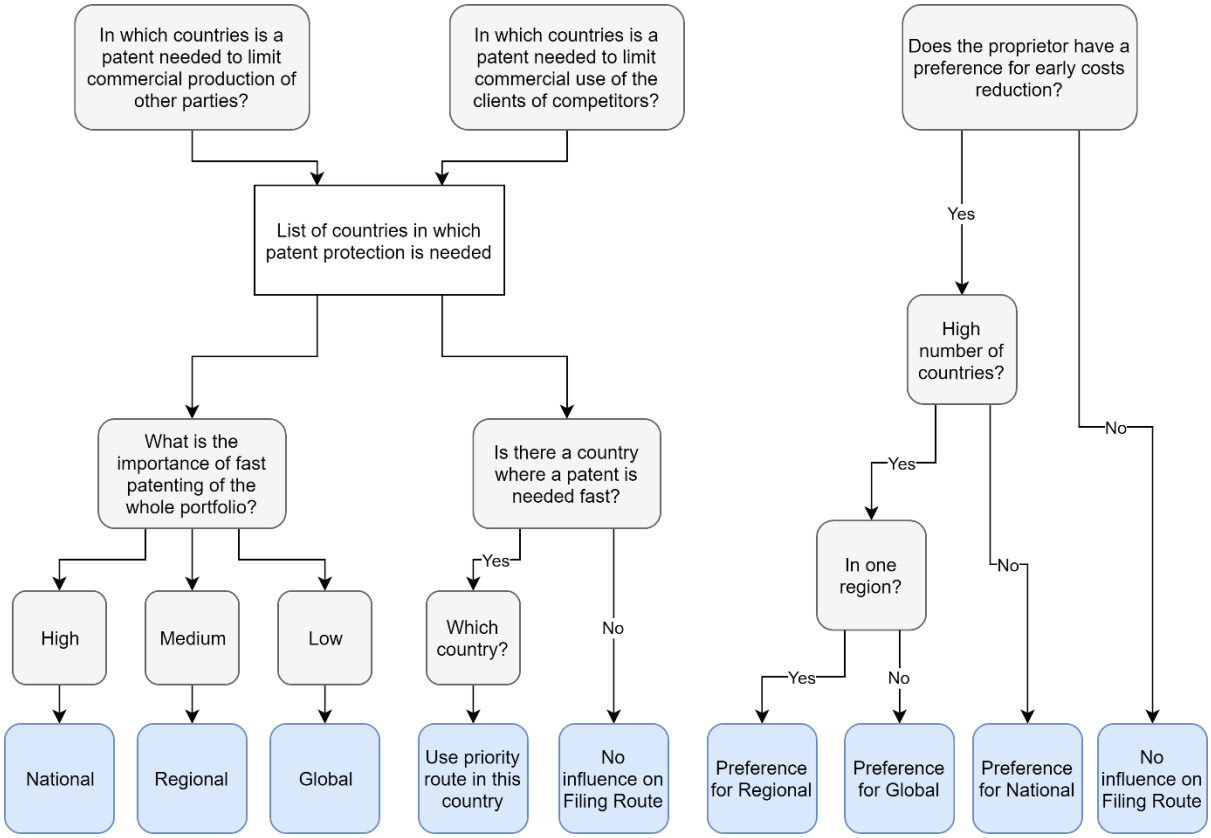

Figure 22 - Decision-Making Framework for Filing Route

In regarding the above figure, it should be noted that the foundations of the information underlying the figure are strictly 'dry' fees of the individual patent offices and the time considerations have been established without taking into consideration the possibility of the filing procedure being hampered by third party opposition or any other kind of obstacle. The costs are very likely to be much higher, especially due to involvement of patent attorneys, and the chances of a patent filing procedure occurring without any set-back, which will likely emerge as higher costs or longer granting periods, is highly improbable.

5.2 Part of the Technology

The second part of the patenting strategy details the part of the technology that is both eligible for patenting and whether these should in fact be patented. In short, the patentability of both the distributed ledger technology and the technical effect of the invention need to be analysed. This will be done per consideration of both the law and the inventor. The law should objectively determine whether the technology is patentable, after which for both parts of the technology, it can be discussed whether these legal bases apply. The inventor of the technology, and how it has been produced is of importance to the patentability as well. For example, if a developer has been introduced into a company on a free-lance basis and has connection with a knowledge institution, chances are that patentability with the company falls apart, based on the agreement between the developer and the institution.

5.2.1 Conditions for patentability

To determine the theoretical conditions for patentability of the invention, we look at the law. Because the Unified Patent Court is not in effect yet, individual law has to be analysed for the country-specific considerations of patentable subject-matter. Considering efficient use of the time of the reader, only the differences with the Patent Cooperation Treaty will be noted for each jurisdiction. Although Article 27 (5) of the PCT states that contracting states have the authority to prescribe additional conditions for patentability or the exclusion thereof in national law, they mostly confer very similar conditions (PCT Art. 27(5), 2001). The PCT procedure involves an International Preliminary Examination, in which the subject-matter of a patent is tested per the criteria of novelty, inventive step, and industrial applicability. For the basis of this discussion, the European Patent Convention will be used as a baseline, as it incorporates the abovementioned inclusions of novelty, inventive step and industrial application in its articles. First, article 52 of the EPC concerns itself with 'patentable inventions', it states that *"European patents shall be granted for any inventions, in all fields of technology, provided that they are new, involve an inventive step and are susceptible of industrial application."* (Art. 52 EPC, 2016). The article then goes on explaining that inventions with the meaning of the aforementioned do not incorporate things like discoveries, aesthetic creations and, important for this research, business methods and software 'as such'. Luckily, the wording of Article 52(3) has been chosen to include 'as such', which gives a degree of leeway for the patentability of software-based inventions, even if they also include business methods.

Article 54 of the EPC confers the notion of novelty per the argumentation that subject-matter of a patent is considered novel if it does not form part of the state of the art (Art. 54 EPC, 2016). The state of the art, also mentioned in article 54, comprises everything made available to the public, through written description, oral description, use or in any other way made available before the date of filing of the intended patent application. What this entails, in practice, is that any document published before the date of filing is considered as 'prior art' and has the potential to invalidate a patent application on the grounds of novelty. An addition to this article prior art also includes the subject-matter of patent applications as filed with any patent office, which are not yet disclosed to the public on that date. Of course, this means that an applicant has the risk that the patent application will be refused on the grounds of novelty based on prior art that has not been made publicly available yet. During an application, generally the patent office will perform a search on prior art to allow for the determination of the novelty of the subject-matter of a patent. However, it is likely to be economically favourable to consult prior art databases before filing a patent application to prevent high search fees for the location of easy-to-be-found prior art.

Inventive step is the second prerequisite for the patentability of subject-matter in a patent application, which, under United States law, is called Obviousness. This aspect of the determination of patentable subject-matter is less objective than novelty as it involves the so-called 'skilled person' (Art. 56 EPC, 2016). This skilled person is supposed to have extensive knowledge in the field of the subject-matter but should not be able to reasonably foresee the invention as depicted by the subject-matter of the patent. The inventive step is the action that is taken to solve a problem in light of prior art, of which the person skilled in the art would not have thought easily because it is non-obvious. For example, the combination of

two prior art documents to create a solution to a technical problem could be classified as an invention. However, if these documents form prior art to the same field, which is also the technical field in which the patent application is filed, the examiner of a patent application could well presuppose obviousness because the assumption that a person skilled in the art would have the technical know-how and knowledge of the existence of the prior art documents to combine them, which would lead to the invention. As the reader can likely feel, this is subject to a relatively high degree of subjectivity, which is why the involvement of patent attorneys for prosecution of a patent might be advised if the contents of the subject-matter are not completely evident. While the inventive step or obviousness are involved in almost all determinations of patentability by patent offices all over the world, the practical differences in granting procedure of patents vary strongly (Abraham, 1995). Also, there seems to be a change over time as per the involvement of inventive step objections, both over time and over region (Philipp, 2006). Philipp argues that the increased influx of patent applications leads to a vicious cycle of inferior quality patents, which leads to an incentive for higher quantities of patent applications. Without delving into the determination of the conclusion of Philipp has any merit, it does indicate the variability and thus the subjectivity of the inventive step in the patentability determination.

The industrial application is the last inclusion of the determination of the patentability of subject-matter of a patent application (Art. 57 EPC, 2016). The refusal of the patent application on the basis of lack of industrial application is less common, especially regarding patents that are filed by a legal entity with the goal of profitability. After all, often profitability involving a patent leads to the application of the technology in industry. Although the point of industrial application could also involve a degree of subjectivity from both the examiner and the applicant, disagreements about the topic do not occur often due to the fact that the incentive for both the examiner and the applicant it to file and allow only subject-matter with industrial application. It simply does not make an awful lot of sense to file for patent application with subject-matter that has no industrial application.

All of the articles mentioned above can be found in Appendix D, along with the respective articles from national law mentioning the above conditions to patentability, should they deviate from the law as prescribed by the EPC. As can be seen there, the United States Code does not have a separate section on industrial applicability of the subject-matter. The industrial applicability as proposed by the European Patent Convention is conveyed by the mention of ‘useful’ under title 35, section 101 of the U.S. Code and is reinforced by case law surrounding the topic. Korean law follows the EPC more closely with the specific mention of industrial applicability, novelty and inventive step. The State Intellectual Property Organization of the People’s Republic of China has similar prerequisites to patentability but has a variation on implementation. The patent law of the PRC conveys the notions of novelty, creativity and practical use, wherein creativity refers to what in the EPC is considered to be inventive step. The inventions must have *“substantive features and indicates remarkable advancements”* (Art. 22 Patent Law of PCR, 2008), which in practice constitutes the same as inventive step. The inclusion of practical use in the Chinese patent law is comparable to industrial application as put forth in the EPC. The invention must be applicable for production or be utilized so as to produce positive results. The Dutch Patent Act follows the same path as the European Patent Convention, as do the patent laws of the United Kingdom and Germany.

So, to determine the patentability of separate parts of the invention in the case of Blockchain technology applications, we must identify the conformity of the parts of the invention to the above statements. As the requirements in the United States and China deviate slightly from the other requirements, they should be dealt with separately.

5.2.2 Framework for the Patentability of Technological Parts

To determine the patentability of either the Distributed Ledger Technology (DLT) or the Technical effect of the Blockchain technology application on the basis of the requirements for patentability in national law procedures, the technology needs to be tested on novelty, inventive step or obviousness or creativity, and industrial applicability or (practical) usefulness, as determined in the above section. As previously mentioned not all patent offices have an examination procedure, which leads to the possibility of a granted patent without conforming to the norms of novelty, inventiveness or industrial application, to a certain extent. Because of strategic considerations, this option has been included in the below framework so as to include the possibility that a proprietor needs a granted patent without ever having to litigate.

As the requirements for patentability for both the Distributed Ledger Technology and the Technical Effect are the same, reference will be made in the decision-making framework to the Technical Part (TP). The procedure then, fort both distinguished parts, is the same.

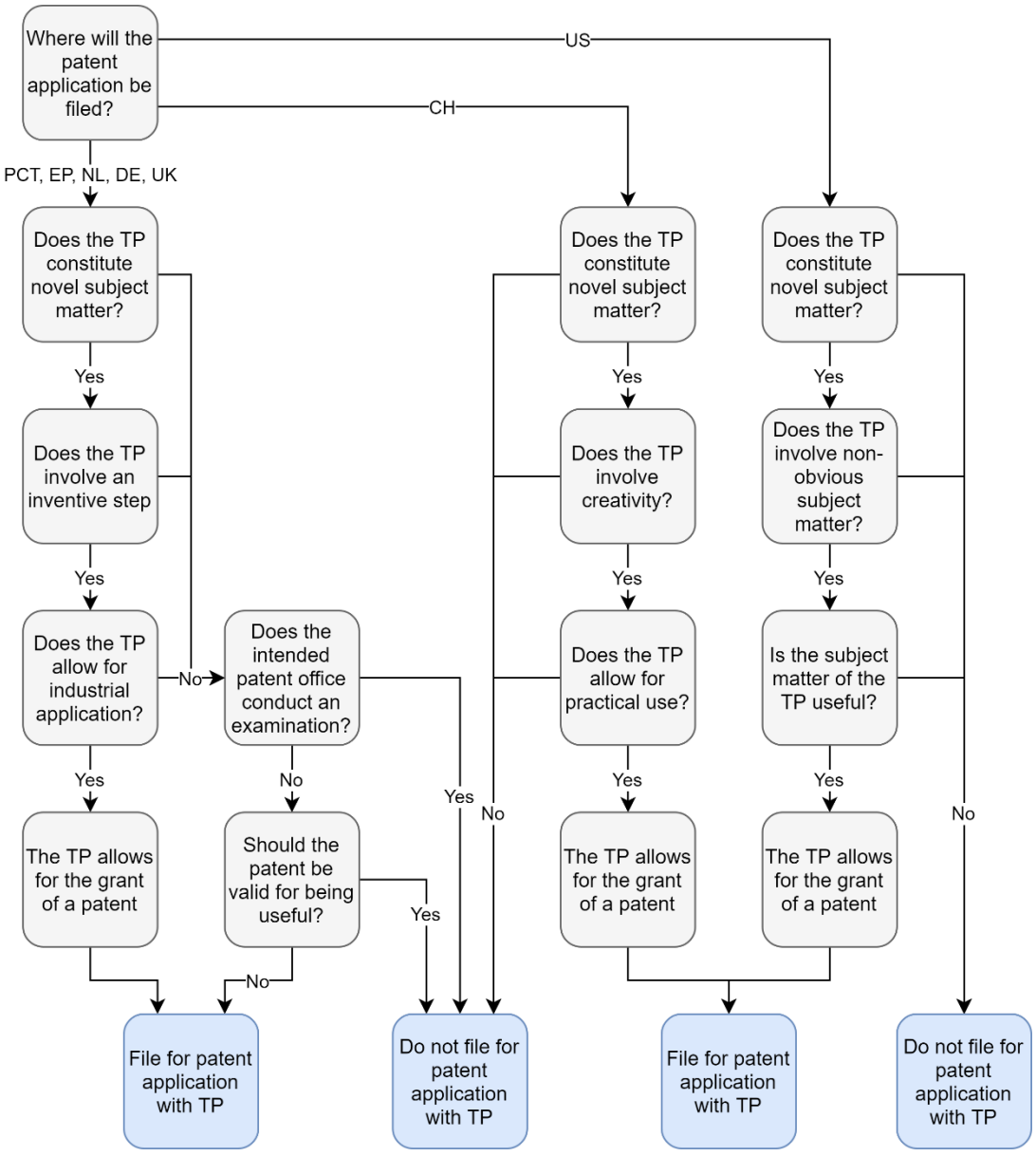

Figure 23 – Decision-Making Framework for Patentability of Technical Part

5.3 Formulation of Claims

The third part of the patenting strategy is the formulation of the claims in a patent application. These formulations are more difficult to indicate exactly because they are highly dependent on the type of technology and the specific ways in which they conform to the prerequisites for patentability. Influencing factors on the formulation of the claims can be identified in characteristics as described in the previous two parts of the patenting strategy. Jurisdictional preference helps determine how claims should be formulated as the examination and search vary per jurisdiction. Also, the patentability of the distributed ledger technology and the technical effect influence the way in which the claims should be formulated so as to increase the changes of a granted patent. This section will discuss the influencing factors that can be determined based on literature and the law, as was done in the previous two sections, along the lines of the claim structure as presented in figure 17.

5.3.1 Claim Preamble

As described in section 4.3.3.1, a claim is made up out of three parts; the preamble; the transitional phrase; and the body as per the Guidelines of the EPO (EPO Guidelines, 2017), see Appendix D. In the determination of the preamble, a consideration should be made as to what category the invention belongs to. As described in the guidelines of the EPO, the most fundamental difference is between a physical entity and an activity. To determine the preamble of an invention, one should simply identify the nature of the invention and choose a preamble that is in accordance with that invention. On paper, that sounds rather easy, which is why this section will not highlight the choice of preamble too much. However, when the lines between physical entity and activity start to get blurred, as they do with computer-implemented inventions, the process of choosing a preamble can get slightly more difficult. For a structure of the choice of preamble, reference is made to the aforementioned figure 16.

5.3.2 Transitional Phrase

The transitional phrase is, as mentioned in section 4.3.3.1, the wording that combines the nature of the invention to the technical features, i.e. the preamble to the body. As a patent attorney aims to create the widest possible protection for his client, he is highly unlikely to choose a limiting (closed) transitional phrase to connect the preamble to the body. In certain, very specific cases, the invention might require a closed phrase to increase the protection of the patent for that embodiment. Upon examination in a litigation procedure of the patent, there will be less discussion about the intended purpose of the invention if a closed transitional phrase was used. Logically, in emerging technology, the openness of a patent is vital as it is not yet clear what the technology will evolve into. Therefore, it is unlikely the patent analysis in chapter 6 will yield any results with a closed transitional phrase.

5.3.3 Claim Body

The decision-making framework on the construction on claims is slightly different from the decision-making frameworks as constructed in the previous sections. The influencing factors in the formulation of the claims in a patent are less distinctive than in the previous sections, as especially with emerging technologies, claim construction becomes more and more opaque as can be seen in Federal Circuit reversal rates over the last years (Moore, 2005). Following the EPC, a claim must be clear and concise and supported by the description (Art. 84 EPC, 2016), in addition to being able to disclose the invention in a manner so that a 'person skilled in the art' can execute the invention (Art. 83 EPC, 2016). The best depiction of the decision-making process is depicted in the below figure (United States of America Patentnr. US2005023478A1, 2005), which exemplifies the relationship between the prior art and the invention so as to develop claims that confer the invention. For each claim, this process needs to be performed. However, for the independent claim the below method might need to be elaborated on, which will be done in the next section. This independent claim is based on the combination of the prior art and the invention, as mentioned in chapter 4. The patent attorney aims to protect as much as possible in the independent claim by implementing the bare minimum for novelty and inventive step requirements. In practice, this means that the patent attorney has a number of features of an invention, of which he must test the necessity in

the independent claim. If the independent claim can do without, the feature will be mentioned in an embodiment of the independent claim in a dependent claim. With reference to the below figure, Hodes has indicated how the initially formulated claims influence a dependent claim, which is not relevant for the independent claim, where the development is much more focussed on individual features of the invention and their merit for patentability through novelty and inventive step requirements.

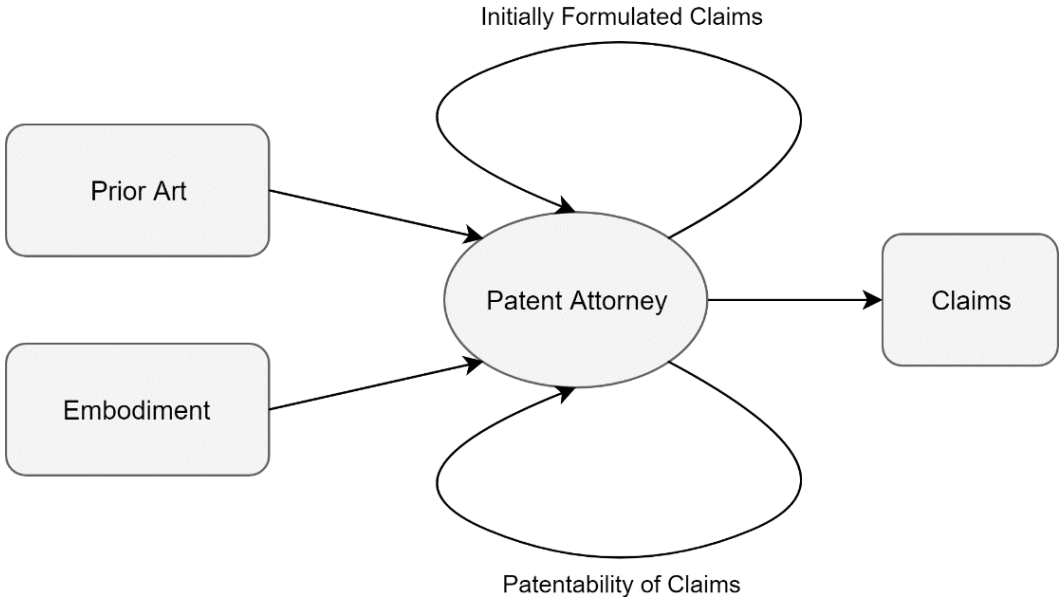

Figure 24 – Influences on Claim Construction (adapted from Hodes, 2005)

The creation of the independent claim is done through selection of the features that result in the claim meeting the requirements for patentability per the aforementioned applicable law. For each feature a determination must be made considering the patentability of the claim, taking into account the requirements of the proprietor as well as the requirements of the patent office examining the claim. The allowable features (or rather combinations thereof) for the creation of the independent claim then, can be constructed by following the below figure. First, allowable (combinations of) features of the invention should be determined, along the lines of requirements as depicted in figure 23. Once these have been determined, the allowable combinations must be considered by the client so as to provide an overview of the options that are most promising for a granted patent (figure 25).

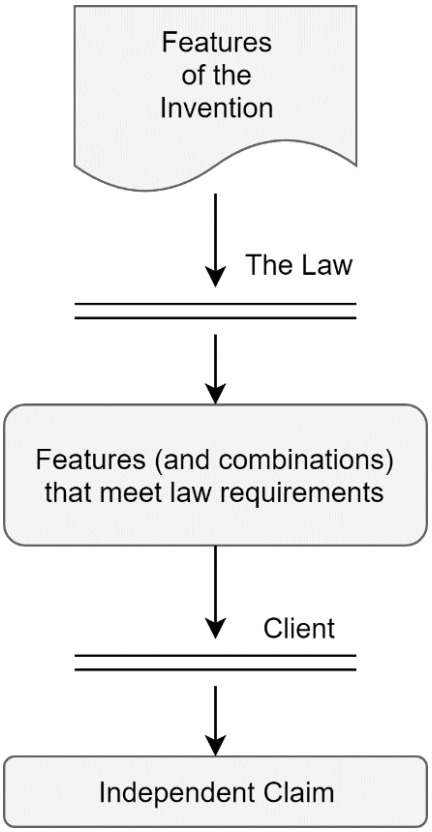

Figure 25 – Independent Claim Construction

Once the independent claim has been constructed, the dependent claims can be added for each feature in each embodiment of the claimed invention, following the procedure described by Hodes in figure 23. With respect to the formulation of the claims, reference is made to figure 17, wherein the type of invention determines the preamble, the specificity of the characteristics determines the transitional phrase and the body is determined by the abovementioned features, which is applicable to all claims, both dependent and independent.

5.4 Summary of Theoretical Decision-Making Framework

This section provided the creation of the theoretical decision-making framework, based on the foregoing chapters. Frameworks have been developed for the determination of the filing route during prosecution, the part of the technology to be protected and the formulation of the claims to confer this protection. As indicated in chapter 3, the sources for this theoretical decision-making framework were literature and intellectual property law in the jurisdictions as discussed in section 2.1.5. As will be indicated below, the filing route was based predominantly on characteristics of the proprietor, the part of the technology by characteristics of the invention and the claim formulation by both.

The theoretical decision-making framework for the filing route was created by looking at jurisdictional effects of infringement litigation, risk, and competition. Jurisdictional infringement, in combination with the competitive situation of the proprietor determine the jurisdictional preferences for patent protection. Furthermore, the preferences of the proprietor regarding time, based on competition as well, determines the jurisdiction of priority route. Also, monetary preferences have been included so as to develop preference outcomes for the filing options.

The framework developed to describe what part of the technology should be protected by the patent is based purely on the law in the various jurisdictions that are considered in this research. The novelty, inventiveness, and applicability requirements have been analysed per jurisdiction and the presence of examination processes have been taken into account. Driving characteristics of the technology are in relation to the state of the art, novelty, inventiveness/non-obviousness, and applicability. These will be further elaborated on in chapter 6.

The model for claim formulation considers both characteristics of the proprietor as well as the technology. The claim has been categorised in three parts; the preamble, the transitional phrase, and the body. The claim preamble is determined by identifying what the nature of the invention is, following figure 16. The transitional phrase is determined per the specificity of the characteristics but is likely to be open in all independent claims due to the limitations on the scope of the patent following a closed transitional phrase. Finally, the body of the patent is determined by referencing embodiments of the claims to prior art and assessing the claims to the conditions of patentability. The patentable claims should then be filed in accordance with the preference of the proprietor.

The above answers the third sub-question, namely the question of how characteristics of the proprietor and the invention affect the outcome of the choices in the protection mechanisms. As mentioned, proprietor characteristics such as time preference, monetary flexibility, and competition affect the filing route and the claim formulation. The characteristics of the invention, and its components, influence the choices of the part of the technology to be protected and the formulation of said protection in the claim formulation.

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6 Validation of Theoretical Decision-Making Framework

"When we are young, friends are, like everything else, a matter of course.
In the old days we know what is means to have them."

– Edvard Hagerup Greig –

In this section, the choices in the process of protecting the intellectual property of Blockchain technology applications, as depicted in the previous section, will be analysed so as to develop a validated framework for decision-making. The chapter will be divided into two sections, improvements to the framework based on patent data and improvements to the framework based on case law and guidelines. These improvements constitute quantitative and qualitative adaptations to the scenarios depicted in previous chapters. For example, this section will provide data to determine the differences in granting rate for Blockchain patents, notwithstanding the fact that the requirements should be equal over jurisdictions. Another example is the inclusion of case law research to determine the way in which a claim should be formulated, as opposed to the structural requirements of claim formulation in the law. Since the results of this chapter will be less binary than in previous cases, no flow-chart for the inclusion of these improvements will be created. Rather, they should be taken into account on a per-case basis, dependent on their applicability. For each decision possibility (chapter 4), some questions need to be answered to understand the relationship between the characteristics of the technology that needs protecting and the choice that needs to be made in the patenting of the technology. First, the Filing Route will be considered through the granting rate, a quantitative measure for the willingness of patent offices in certain jurisdictions to provide patent protection for Blockchain technology applications. To provide the reader with a preliminary assumption of willingness to provide patent protection in the future, a comparison is drawn with computer programs. In the later section, case law in granting procedures – either appeal or opposition – or litigation will be discussed to try to identify what filing routes are most prone to limitations (if at all).

Second, the Technology will be analysed so as to determine what parts of the technology will be protected by the patents. This will be done per analysis of granted patents, which will provide an indication as to the patentability of either the distributed ledger and the technical effect of an invention using an existing distributed ledger. Here, we will only determine what technical characteristic is patented. These patents will be used in the discussion about claim formulation as well. In the case-based section, the part of the technology will be validated by analysis of a selection of prosecution or litigation cases linked to similar technology.

Finally, the formulation of the claims will be analysed following the aforementioned patents. In these patents, the type of claim, type of transitional phrase and the number of independent and dependent claims will be determined. The case-based section will be founded in guidelines which are based on aforementioned case law (see table below).

Table 9 - Validation Methods

	Data-Based (6.1)	Case-Based (6.2)
Filing Route	Granting Rate	Case Law
Part of Technology	Patents	Case Law
Claim Formulation	Patents	Guidelines based on Case Law

Notably, the case-based section of this research is likely to include specific outcomes on certain topics, rather than general outcomes for characteristics of the technology. The discussion on case law with respect of Blockchain technology will be performed following the most important decisions about software patents and subsequently zooming in on the decisions that deal with characteristics which are present in Blockchain technology. The case law therefore does not necessarily have to constitute Blockchain technology, as long as the decision references to a characteristic that is relevant to the technology.

6.1 Data-Based Improvements

6.1.1 Filing Route – Granting Rate

The filing of a patent is intended to lead to a granted patent, this much is clear. However, the route that is taken to accomplish this differs on some aspects. If we analyse Patents containing the words Blockchain or a combination of Distributed and Ledger within three words distance of each other, in the Title, Abstract or Claims, we see a total of 1244 applications and 216 grants (PatBase, 2018). It seems that obtaining a grant is quite difficult in Blockchain technology. Notably, the proportion of granted patents, relative to the proportion of applications in the United States of America seems to be much higher than in other regions.

In the following figure, we can see the jurisdictional patent applications since 2006, ranked according to the level of their filing activity. The jurisdictions most strongly represented in the applications of Blockchain or distributed ledger patents are the United States, China and the European Patent Office, followed by Canada, Australia and South Korea. A point of consideration regarding the applications is the presence of WIPO. This represents the PCT filing route, of which no granted patents can result. The inclusion of WIPO applications in the figure is an arbitrary one, as patents later to be filed through national or regional offices are still included. To derive any conclusions from the level of applications in different jurisdictions, we must compare the data with the amount of granted patens in the aforementioned countries.

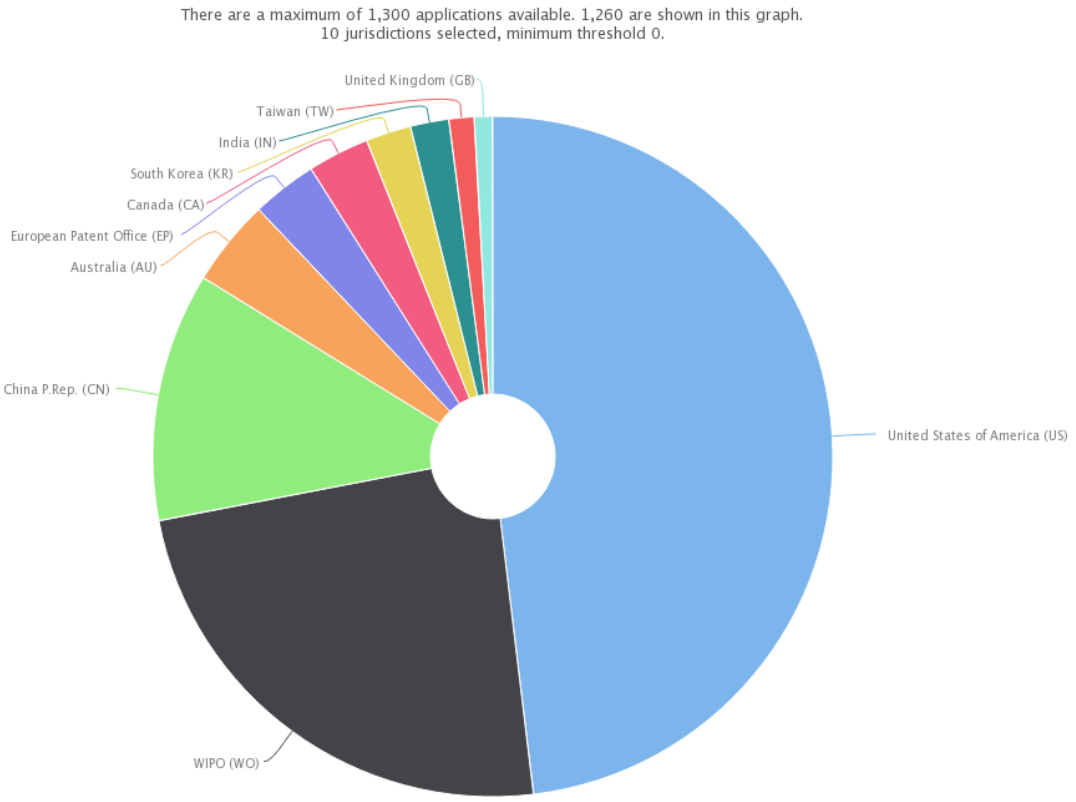

Figure 26 – Top 10 Applications by jurisdiction (Source: PatBase)

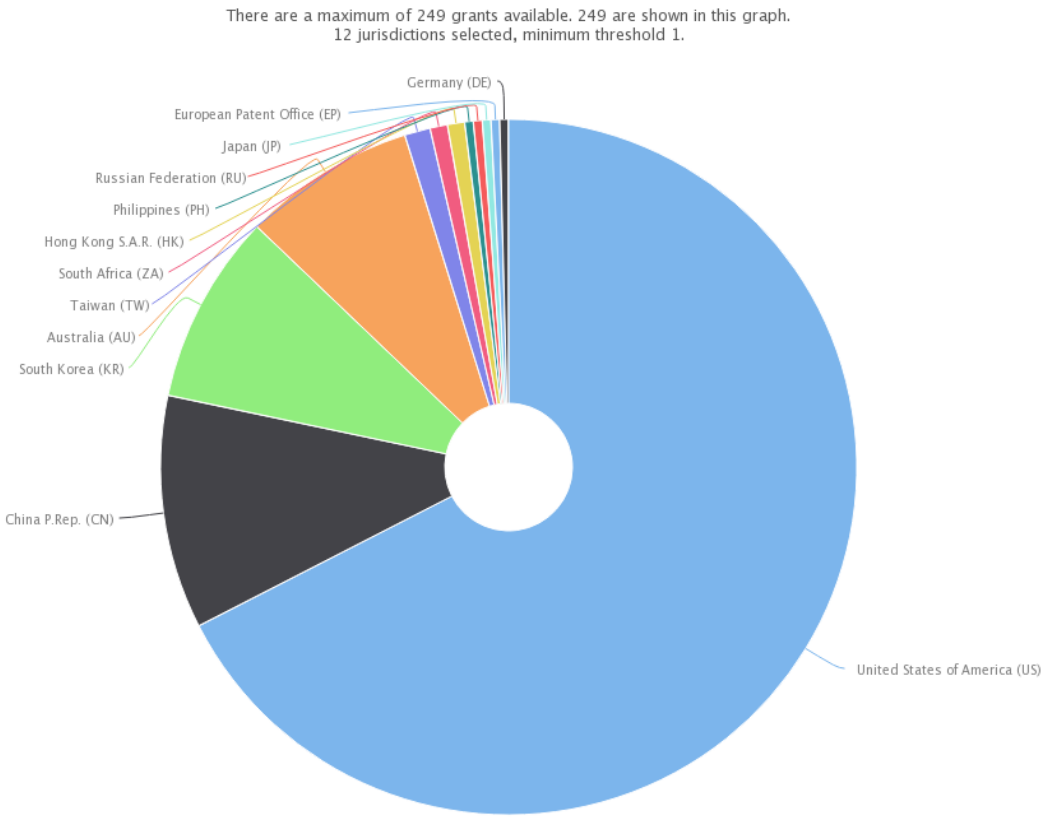

Figure 27 – Top 12 Grants by jurisdiction (Source: PatBase)

Figure 26 depicts the amount of granted patents per jurisdiction, also since 2006. It shows that most grants are given out in the United States, followed by China, South Korea, Australia, Taiwan and South Africa. A notable difference in the ordering of these two graphs is South Korea, who is the third most active country in granting Blockchain or distributed ledger patents but seventh in applications, pointing to a high granting rate. Another noteworthy discrepancy between the two data sets is the European Patent Office. From a relatively high application rate of 39 applications, only 1 is granted, the proprietor being British Telecommunications, a patent on mitigating attacks on a Blockchain data structure. Canada is even more strict with its patent applications, of the 37 applications, none was granted.

In Table 2, the data used to produce the previous figures is presented, along with the Granting Rate. Or the percentage of applications resulting in a national grant. As mentioned, the granting rate of South Korea is exceptionally high, while the European Patent Office seems more stringent with supplying patents to its applicants.

Table 10 - Jurisdictional Data on Blockchain or Distributed Ledger Patents (Source: PatBase)

#	Jurisdiction	Applications	Grants	Granting Rate
1	United States of America	606	168	27,7%
2	China P. Rep.	149	27	18,1%
3	South Korea	27	22	81,5%
4	Australia	52	20	38,5%
5	Taiwan	15	3	20,0%
6	Hong Kong S.A.R.	2	2	100,0%
7	South Africa	2	2	100,0%
8	Japan	4	1	25,0%
9	Germany	6	1	16,7%
10	European Patent Office	39	1	2,6%
11	Philippines	2	1	50,0%
12	Russian Federation	4	1	25,0%
13	Vietnam	1	0	0,0%
14	Mexico	1	0	0,0%
15	Netherlands	1	0	0,0%
16	WIPO	301	0	0,0%
17	Eurasian Patent Organization	1	0	0,0%
18	Singapore	10	0	0,0%
19	Czech Republic	1	0	0,0%
20	India	23	0	0,0%
21	Canada	37	0	0,0%
22	Spain	1	0	0,0%
23	France	4	0	0,0%
24	United Kingdom	11	0	0,0%

Of the presented data, the first 10 jurisdictions have been depicted in the figure 28, showing the high granting rate of South Korea and the very low granting rate of the European Patent Office. The average granting rate over all patent applications is roughly 19%, as shown by the blue line. The United States, with just under 28% sits well above this average, as does Australia. Taiwan and China are closer to the average with 20% and 18,1%, respectively.

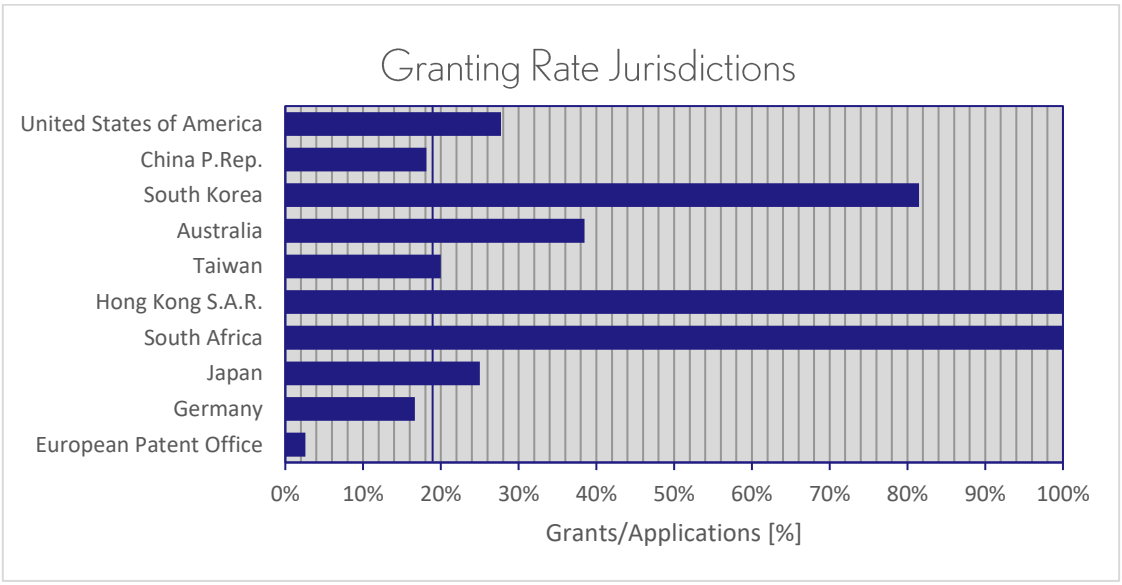

Figure 28 - Granting Rate per Jurisdiction, Blockchain or Distributed Ledger (Source: PatBase)

In the current field of intellectual property law, it seems filing for patent protection in Korea is your best bet of getting a patent granted. The European Patent Office seems not to be inclined to grant patents at all. Apart from the high granting rate, Hong Kong and South Africa have been excluded from the conclusions due to their small batch and the fact that South Africa does not have an examination procedure. The United States and Australia also have above average granting rates, Germany and China look to be areas to avoid.

To get an idea of how the field of intellectual property law will develop over time, a comparison will be drawn with the field of Software. Just like Blockchain, software patents are often not patentable under non-patentable inventions in most patent law. However, over the years, many patents have been granted built upon software. To draw a comparison between Blockchain or distributed ledger technology and software, we identify all patents using the words Computer Program within a one-word distance in the Title or Abstract, over the same period as the analysis for Blockchain or distributed ledger, namely from 2006 onwards. This provided a data set of 217.103 patent applications, with a set of 93.605 grants.

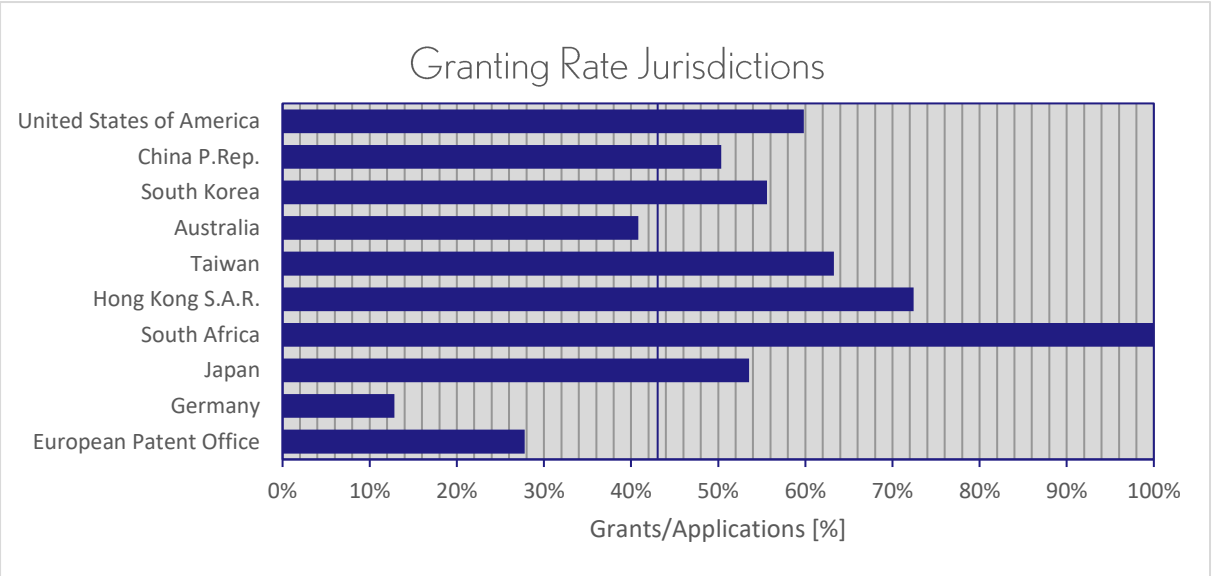

Figure 29 - Granting Rate per Jurisdiction, Computer Program (Source: PatBase)

As can be seen in figure 29, the granting rates across the various jurisdictions is much higher, its average is 43%, over twice as high as Blockchain or Distributed Ledger applications. This points towards expectations for future patentability. While not conclusive, the overarching technology of Blockchain technology, namely that of computer programs, seems to allow for easier granting over time. A comparison of both data sets allows for an assumption of future patentability of the technology, as compared to the current state of patentability of the technology.

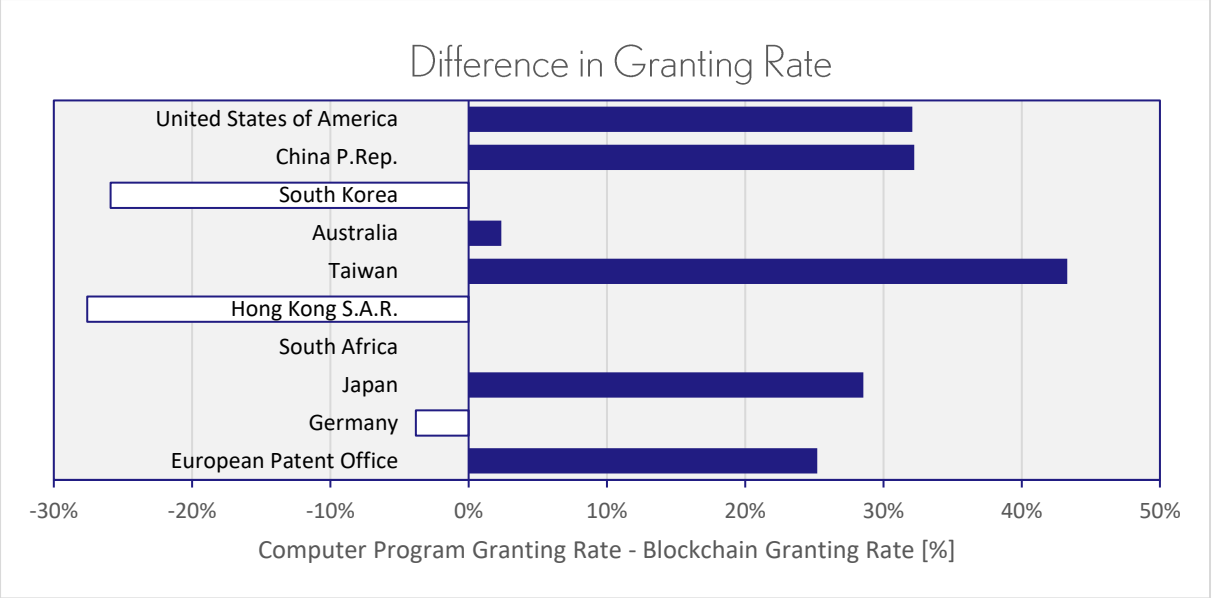

Figure 30 - Granting Rate Difference, Blockchain and Computer Program (Source: PatBase)

Concluding, by analysis of the granting rate of Blockchain or Distributed Ledger technologies and comparison with Computer Program granting rate (figure 30), an assessment can be made identifying the best options for filing strategy in different countries. The data suggest that the jurisdictions most likely to provide protection at this point in time are South Korea, Australia, the United States of America and Japan, respectively. However, assuming that computer programs provide a comparable view of patentability when the technology matures, the granting rates of South Korea and Germany decline, and the granting rate of Taiwan, the United States and China rise. This leads to believe that in the future, granting procedures of Blockchain or Distributed Ledger technology will be highest in Taiwan, the United States of America, South Korea and Japan, followed closely by China.

Noteworthy considerations of this conclusion are the negative difference in granting rate of South Korea and the strong increase by the European Patent Office. This points towards initial optimism by the Korean Patent Office regarding the technology and conservatism by the European Patent Office. As the technology matures, especially with the inclusion of a standard by the International Standard Organization and the development of the Unified Patent Court, there might be some considerable deviations from the prognosis, especially with respect to the European Patent Office.

6.1.2 Part of Technology – Patent Analysis

For this section and the following section, a patent analysis needs to be performed. For the analysis of the Part of the Technology, we look into patents referring to Blockchain technology and identify whether the patent protects the distributed ledger or only a technical effect by use of a Blockchain-based system. These patents will be categorized following a number of characteristics, so as to also provide information with for the following sections. To identify the patents that will be used in these sections, we use Google Patents as it easily provides access to the actual document and translations, if necessary. As earlier, limitations on jurisdiction will be adhered to, as will an earliest priority of 01-01-2008 (the year of the Bitcoin publication), the English language (or at least a translation into English), and a granted status. These search limitations yielded a result of 163 documents that were all analysed for applicability of the research. If a patent holds the word 'Blockchain' but the invention is not actually about Blockchain the patent will be rejected. What remains is shown in the below table, for a full overview of details, titles, assignees, inventor and all the important dates, see Appendix E. It should be noted that some translations of the patents were not sufficient to determine the type of preambles or what the patent covered with respect to the part of the technology. The changes to the below table will be indicated per section in the below sections. By means of an example, the reader is invited (challenged) to grasp the intended invention of the following section of claim one of the first patent in the below list (Korea Patentnr. KR101812969B1, 2017):

"In the method of the transaction in which the block chain (Blockchain) encrypted money (Crypto-Currency) without the issuing body of the currency in a structure collects the encrypted transfer recording made in the network, first, the presenter will block the donor side chain based digital virtual currency transactions of Web app execution step of executing the app 310 or hybrid web for mounting (…)"

As evident from the above, it can be determined that the preamble constitutes a method, but hardly how that method relates to either the technical effect from the use of a Blockchain in the invention or a new method of performing transactions, using a novel method for a distributed ledger.

Table 11 - Patents for Analysis (Source: Google Patents)

#	Patent Number	Title	Priority Date
1	KR-101812969-B1	System for dealing a digital currency with block chain with preventing security and hacking	2017-11-06
2	CN-207123875-U	Based on the block chain technique tachograph	2017-09-20
3	US-9870508-B1	Securely authenticating a recording file from initial collection through post-production and distribution	2017-06-01
4	US-9882918-B1	User behavior profile in a Blockchain	2017-05-15
5	KR-101784197-B1	System and method of donating using assets including digital virtual money based on Blockchain	2017-03-07
6	US-9824031-B1	Efficient clearinghouse transactions with trusted and un-trusted entities	2016-10-28
7	CN-106504008-B	One kind of method is based on a fair contract signing block chain	2016-10-24
8	US-9747586-B1	System and method for issuance of electronic currency substantiated by a reserve of assets	2016-06-28
9	NL-2016935-B1	Method and device for controlling at least one electric apparatus	2016-06-10
10	US-9635000-B1	Blockchain identity management system based on public identities ledger	2016-05-25
11	US-9774578-B1	Distributed key secret for rewritable Blockchain	2016-05-23
12	US-9888007-B2	Systems and methods to authenticate users and/or control access made by users on a computer network using identity services	2016-05-13
13	GB-201607476-D0	Operating system for Blockchain IOT devices (PCT)	2016-04-29
14	US-9513627-B1	Autonomous coordination of resources amongst robots	2016-04-25
15	US-9862222-B1	Digitally encoded seal for document verification	2016-04-04
16	KR-101694455-B1	Method and apparatus for exchanging or remitting Blockchain-based virtual currency	2016-03-14
17	US-9794074-B2	Systems and methods for storing and sharing transactional data using distributed computing systems	2016-02-04
18	US-9825931-B2	System for tracking and validation of an entity in a process data network	2016-01-26
19	US-9847997-B2	Server based biometric authentication	2015-11-11
20	GB-201517581-D0	A Transferable value or rights token authenticated using a Blockchain (PCT)	2015-10-06
21	US-9807106-B2	Mitigating Blockchain attack	2015-07-31
22	US-9298806-B1	System and method for analyzing transactions in a distributed ledger	2015-07-08
23	US-9870562-B2	Method and system for integration of market exchange and issuer processing for Blockchain-based transactions	2015-05-21
24	US-9703986-B1	Decentralized reputation service for synthetic identities	2015-05-13

#	Patent Number	Title	Priority Date
25	US-9397985-B1	System and method for providing a cryptographic platform for exchanging information	2015-04-14
26	US-9667600-B2	Decentralized and distributed secure home subscriber server device	2015-04-06
27	US-9875510-B1	Consensus system for tracking peer-to-peer digital records	2015-02-03
28	US-9836908-B2	System and method for securely receiving and counting votes in an election	2014-07-25
29	US-9608829-B2	System and method for creating a multi-branched Blockchain with configurable protocol rules	2014-07-25
30	US-9135787-B1	Bitcoin kiosk/ATM device and system integrating enrollment protocol and method of using the same	2014-04-04
31	US-9436935-B2	Computer system for making a payment using a tip button	2014-03-17
32	US-9338148-B2	Secure distributed information and password management	2013-11-05
33	US-9853819-B2	Blockchain-supported, node ID-augmented digital record signature method	2013-08-05
34	US-9876775-B2	Generalized entity network translation (GENT)	2012-11-09

To perform an analysis on the part of the technology that has been patented, the above patents have been used. These are all granted patents and should provide a degree of insight into the patentability of the various parts of the Blockchain Technology. Although the grants will not be set off against applications due to the limited timeframe of this research, the results of the granted patents should at least indicate what can constitute a granted patent and perhaps even what methods can be used to allow for a granted patent. As can be seen in the below table, the patents from Korea and China have been excluded from analysis in this section as the translation was not sufficient to fully understand the subject-matter for a determination of the patented part of the technology as this requires a full understanding of the invention. Without fully grasping what the patent is aiming to protect, such an analysis would yield a high degree of mistakes. Therefore, these results have been excluded (see table 12).

Table 12 - Part of Technology Analysis (Source: Google Patents)

#	Patent Number	Type of Technology	Priority Date
1	KR-101812969-B1	?	2017-11-06
2	CN-207123875-U	?	2017-09-20
3	US-9870508-B1	Distributed Ledger	2017-06-01
4	US-9882918-B1	Technical Effect	2017-05-15
5	KR-101784197-B1	?	2017-03-07
6	US-9824031-B1	Distributed Ledger	2016-10-28
7	CN-106504008-B	?	2016-10-24
8	US-9747586-B1	Technical Effect	2016-06-28
9	NL-2016935-B1	Technical Effect	2016-06-10
10	US-9635000-B1	Both	2016-05-25
11	US-9774578-B1	Distributed Ledger	2016-05-23
12	US-9888007-B2	Technical Effect	2016-05-13
13	GB-201607476-D0	Technical Effect	2016-04-29
14	US-9513627-B1	Technical Effect	2016-04-25
15	US-9862222-B1	Technical Effect	2016-04-04
16	KR-101694455-B1	?	2016-03-14
17	US-9794074-B2	Technical Effect	2016-02-04
18	US-9825931-B2	Technical Effect	2016-01-26
19	US-9847997-B2	Technical Effect	2015-11-11
20	GB-201517581-D0	Both	2015-10-06
21	US-9807106-B2	Technical Effect	2015-07-31
22	US-9298806-B1	Distributed Ledger	2015-07-08
23	US-9870562-B2	Technical Effect	2015-05-21
24	US-9703986-B1	Both	2015-05-13
25	US-9397985-B1	Distributed Ledger	2015-04-14
26	US-9667600-B2	Both	2015-04-06
27	US-9875510-B1	Distributed Ledger	2015-02-03
28	US-9836908-B2	Technical Effect	2014-07-25
29	US-9608829-B2	Distributed Ledger	2014-07-25
30	US-9135787-B1	Technical Effect	2014-04-04
31	US-9436935-B2	Both	2014-03-17
32	US-9338148-B2	Distributed Ledger	2013-11-05
33	US-9853819-B2	Distributed Ledger	2013-08-05
34	US-9876775-B2	Distributed Ledger	2012-11-09

The results of this analysis are displayed in the following figure and show a total of 29 analysed patents wherein 5 patens aim to protect both the technical effect resulting from the use of the distributed ledger system and the distributed ledger itself (figure 31). It seems that there is no conclusive evidence as to the best strategy to get a patent granted with reference to the part of the technology that a patent aims to protect. However, even though the results might not be sufficient to adequately provide the reader with an assumption of what type of technology should be patented but the lack of clear distinction in the granted patents as described above is remarkable. This points towards a conclusion that was not earlier identified as an option, namely that the optimal way to patent a Blockchain-based invention is to not identify the difference between the distributed ledger and the technical effect that the invention accomplishes with the Blockchain but rather claim the system as if it were new and subsequently add a feature to the independent claim that induces novelty and inventiveness. The way these patents are written is a consequence of the legal obligations to which a patent application is subjected. A patent must disclose the relevant features to allow a person skilled in the art to execute the invention and a person skilled in the art of cryptography would know what Blockchain to use for the intended solution. Therefore, in a patent application of a Blockchain invention, we see almost no indication as to what type of Blockchain will be used in the execution of the invention as this is not a prerequisite for a granted patent in light of the knowledge of the skilled person. As a result, if the patent discloses the methodology of a Blockchain, the skilled person would recognise it as such and subsequently identify the Blockchain technology most suitable for the application of the invention.

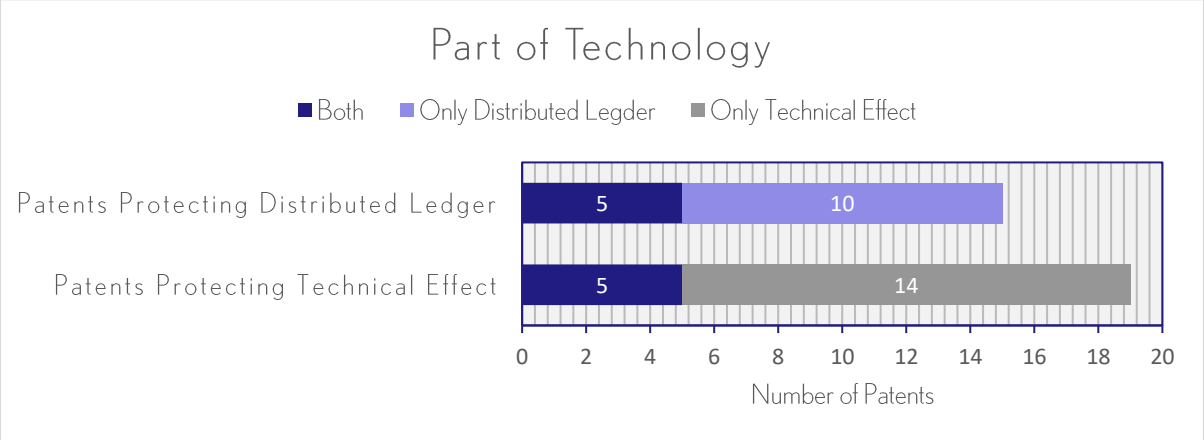

Figure 31 - Patent Analysis Part of Technology

Following from the aforementioned, the conclusion that can be drawn from the above analysis holds no reference to the binary choice of distributed ledger or technical effect from the use of such an invention. Rather, it suggests that any subject-matter of a patent application should provide the skilled person sufficient incentive to accomplish the intended effect with said invention. As a result, even if the distributed ledger does not meet the novelty or inventiveness requirements for patentability, it can be included in the subject-matter. As an example, the first independent claim of patent 18 is presented, held by Bank of America Corporation, wherein a *"System for tracking and validation of an entity in a process data network"* is disclosed. While the invention aims to produce authentication-questions based on data stored in a distributed ledger network, thereby identifying the technology only as the use of a technical effect of the Blockchain, rather than a novel way of performing the transactions, the method in which the system operates is described following a description in the independent claim, which includes the use of a Blockchain network in significant detail, thereby disclosing prior art:

"A system for tracking and validating instances of a user, the system comprising:

a memory device with computer-readable program code stored thereon;

a communication device;

a processing device operatively coupled to the memory device and the communication device, wherein the processing device is configured to execute the computer-readable program code to:

receive an initial identification for the user at one or more nodes of the block chain distributed network;

update a distributed ledger with the initial identification via transmission of data from the one or more nodes to the distributed ledger associated with the block chain distributed network;

receive one or more subsequent identifications for the user at the one or more nodes of the block chain distributed network, wherein the received one or more identifications identify morphs in the user identification over a time period;

confirm, via communication with third party systems, the received one or more subsequent identifications are associated with the user;

link the one or more subsequent identifications for the user to the initial identification to generate a timeline illustrating morphing of user identification over time, wherein the timeline illustrates changes in user identification including changes in signatures, physical attributes of the user, and geographic relocations of the user;

correlate user facts received from the one or more nodes of the block chain distributed network and third-party systems to the timeline, wherein user facts include a signature the user has previously used, locations where and when the user lived, and physical attributes of the user at various previous times;

generate one or more authentication questions based on the user facts and timeline; and

present the generated one or more authentication questions to the user via a user device for user access into third party secure locations." (United States of America Patentnr. US9825931B2, 2017).

What follows from this example, and similar claims in the other patents is that there seems to be no preference for the patentability of either the Distributed Ledger or the Technical Effect resulting from said Distributed Ledger. Rather, the patents show that the system that is used to achieve the solution for the intended problem, be it the fundaments of transactional methods in a distributed ledger or a technical effect achieved by implementation of such a system in a specific field, must be disclosed in the patent so as to allow a person skilled in the art to execute the invention. In practice, for inventions that use a distributed ledger system to accomplish their intended effect, the distributed ledger must always be disclosed in the patent. The extent to which the functionalities of this system must be disclosed differ, depending on the type of invention that is described in the patent. The specific functionality of the distributed ledger system that is disclosed in the patent should support the feature of the claim on which novelty and inventiveness is dependent.

6.1.3 Claim Formulation – Patent Analysis

Using the earlier selection of patents, an analysis of claim formulation can be created. For every patent, the preamble and the transitional phrase have been identified in the independent claims (ICs). The below table provides a summary of the results, for a full overview see Appendix F. Note that in the below table, the connotation of the transitional phrase refers to all claims.

Table 13 - Claim Formulation Analysis (Source: Google Patents)

#	No. of ICs	Type of preamble(s)	Transitional Phrase(s)
1	1	1) Method	?
2	?	?	Open
3	3	1) Method, 2) System, 3) Computer readable storage medium	Open
4	3	1) Method, 2) System, 3) Computer readable storage medium	Open
5	?	?	?
6	3	1) Method, 2) System, 3) Storage medium	Open
7	1	1) Method	Open
8	2	1) System, 2) Computer readable storage medium	Open
9	2	1) Device, 2) Method	Open
10	3	1) System, 2) Method, 3) System	Open
11	3	1) System, 2) Method, 3) Product	Open
12	6	1) Controller, 2) Controller, 3) Controller, 4) Controller, 5) Computer storage medium, 6) Method	Open
13	2	1) System, 2) Method	Open
14	3	1) Method, 2) Method, 3) Method	Open
15	3	1) Device, 2) Method, 3) Computer readable storage media	Open
16	2	1) Method, 2) Method	Open
17	3	1) System, 2) Computer readable storage medium, 3) Method	Open
18	3	1) System, 2) Computer program, 3) Method	Open
19	3	1) Method, 2) An identity manager, 3) Method	Open
20	2	1) System, 2) Storage medium	Open
21	2	1) Method, 2) System	Open
22	2	1) System, 2) Method	Open
23	2	1) Method, 2) System	Open
24	1	1) Machine	Open
25	2	1) System, 2) Method	Open
26	3	1) Device, 2) Method, 3) Computer readable storage medium	Open
27	1	1) System	Open
28	2	1) System, 2) Method	Open
29	2	1) Method, 2) System	Open
30	4	1) Device, 2) Method, 3) Device, 4) Method	Open
31	2	1) System, 2) Method	Open
32	3	1) Method, 2) Device, 3) Computer readable memory device	Open
33	1	1) Method	Open
34	2	1) Method, 2) Method	Open

As evident from table 13, and as also shown in the below figure, the total number of independent claims, over the 32 patents of which this could be determined, was 77 (figure 32). Of these ICs, the majority were method claims, with 34, followed by 19 system claims, 10 computer storage medium claims and 6 device claims. The last five preambles, controller, identity manager, computer program, machine and product, were all mentioned in only one patent, albeit that patent 12 had four controller claims (United States of America Patentnr. US9888007B2, 2018). A remarkable finding of this analysis is the fact that only four of the analysed patents have no method claim, which points towards the suggestion that the inclusion of a method claim is a prerequisite for a Blockchain-based patent. Furthermore, the inclusion of a system claim looks to be promising as over half of the analysed patents have a system claim, namely eighteen.

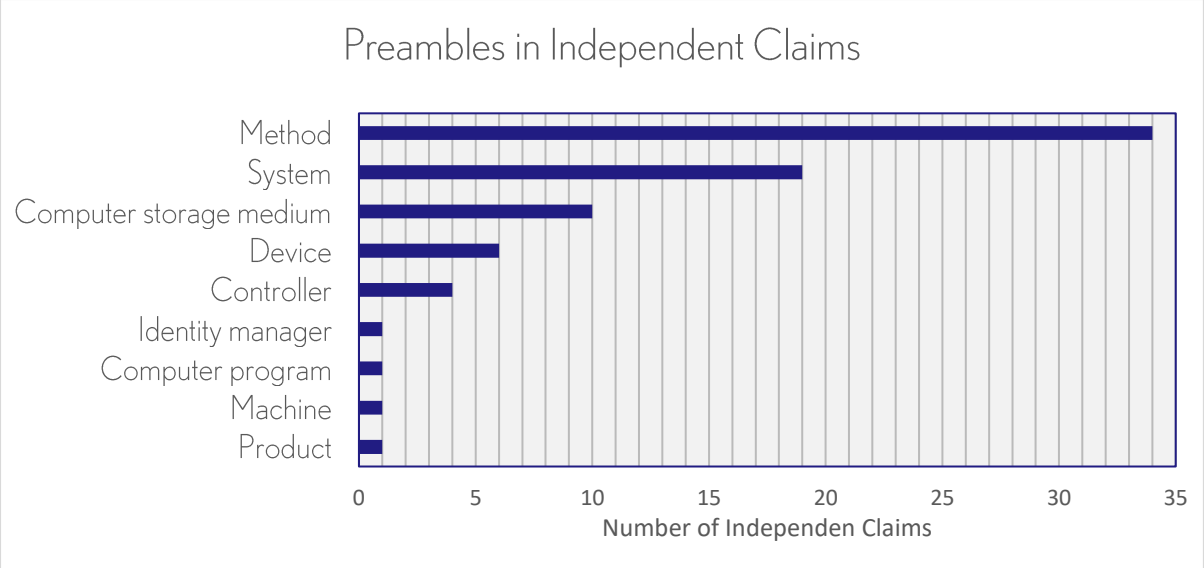

Figure 32 – Independent Claim Preamble Analysis

Based on the above the formulation of the preamble of a Blockchain-based patent should include a method claim, as it is fundamentally an activity that is performed to execute the invention. When looking at a system claim, the interpretation of the meaning of such a claim in light of the invention that it needs to protect should be taken to describe an activity, as the system, with the meaning of the independent claims as described above, does not constitute a physical invention. Further elaboration on the preambles will be provided in section 6.2.3 of this document.

The transitional phrases have earlier been proposed to be open, since the use of a closed transitional phrase would be limiting to the subject-matter. As indicated in table 13, this is indeed the case. While closed transitional phrases exist, in some patents, they are rarely used and should not, in fact be used in the claims of a Blockchain patent.

6.2 Case-Based Improvements

In addition to the above section in which the assumptions of the theoretical decision-making framework are subjected to an analysis of granting rate and an analysis of granted patents, this section aims to provide additional insight into the conciseness of the theoretical model as presented in chapter 5 by inclusion of case law and guidelines. This section will first discuss the most important decisions in case law with respect to the field of software patents, and subsequently the ramifications of those decisions for Blockchain technology applications. Thereafter, the claim formulation as depicted in previous sections will be elaborated on by examination of guidelines for claim development as provided by patent offices, insofar as this has not been clarified by the conclusions drawn from case law. The case law-section will provide insights for the filing route and the part of the technology, while the guidelines provide additional insight into claim development. The section on case law will be split into case law from the United States of America and case law from Europe. It should be noted that the vast majority of the case law regarding the topic will emanate from the United States of America as their system of law, as mentioned is strongly connected to case law. For that reason, conclusions being drawn from case law in other jurisdictions than the United States are founded in the assumption that the methodology of intellectual property law, as partly unified under institutions like WTO and WIPO, are comparable over jurisdictions. Since the field of intellectual property law in the United States is based on case law to a much larger extent than European intellectual property law, it is likely that the subject of European case law is broader than United States case law. Even so, case law from the European Patent Office will be included as well, as per the unified prosecution procedure, the European case law covers the generic methodology of coping with changing technology in the field of intellectual property law. Other jurisdictions as earlier discussed in this research have been excluded from this qualitative section for practical reasons, case law decisions are complex texts and current translation methods, or the writer's ability to speak the necessary languages are insufficient to draw any valid conclusions. To ensure the quality of the result of this section, United States and European case law will be discussed.

The cases are selected based on the framework adapted from Cane, et al., as depicted in section 3.1.1 wherein the case comparison framework comprises four steps. First, the case selection will be performed by means of backward snowball iteration, as was done in the literature review, starting from *Alice* in the United States and G 8/03 in Europe (explained below). The domains for assessment of the cases have been categorised as infringement limitations such as joint infringement and subsequently patent-eligibility following excluded subject matter and inventive step or obviousness. The congruence with the application at hand in this research is determined by referencing to characteristics of Blockchain technology as inter alia discussed in this research. Further, the outcomes and relevant conclusions are discussed per case below. The lessons from the case law will be implemented qualitatively, as mentioned, in the framework as added matter rather than drawing a comparison with the theoretical outcome as proposed in the framework by Cane, et al., seeing as the case law refers to software-patents in general, rather than specifically to Blockchain technology. With the possibility to merely draw conclusions on parts of the technology, the theoretical determination of the outcome would not yield useable results.

6.2.1 Case Law in the United States of America

The below cases will be handled roughly chronologically and for each case, take-aways are formulated with reference to the subject of this research. Finally, an overall conclusion regarding decisions will be formulated. Furthermore, the below cases refer to two generic subjects, namely those of joint infringement, i.e. who is liable for infringement claims in the case of a distributed network (see List of Definitions), and subject-matter patent-eligibility, i.e. the claimed subject-matter must conform to the requirements for patentability. The below table shows what cases will be discussed and when they have been decided.

A very important case to consider in this section is Alice Corp. v. CLS Bank (*Alice*), wherein the matter of validity of software patents is discussed (Alice Corp. v. CLS Bank, 2014). This decision is the most notable decision in US case law with respect to the intellectual property of software as it was decided that abstract ideas as put forward in the contested claims of Alice Corporation were in fact not eligible for patent protection. As such, the principle of patenting software was endangered (Castanias, Maiorana, & Johnson, 2014). However, before the contents of Alice and its implications can be properly discussed, it is imperative that the underlying Supreme Court decisions are well understood. The decision of *Alice* is the first clear example of the verdict on patent eligibility of software patents and was based predominantly on three earlier decisions.

Table 14 – United States Case Law for Analysis

#	Case Name	Plaintiff	Defendant	Decided
1	Gottschalk v. Benson	Gottschalk, Acting Commissioner of Patents	Benson et al.	20-11-1972
2	Parker v. Flook	Parker, Acting Commissioner of Patents and Trademarks	Flook	22-06-1978
3	Diamond v. Diehr	Diamond, Commissioner of Patents and Trademarks	Diehr et al.	03-03-1981
4	State Street Bank v. Signature	State Street Bank & Trust Co.	Signature Financial Group, Inc.	23-07-1998
5	Bilski v. Kappos	Bilski et al.	Kappos, Under Secretary of Commerce for Intellectual Property and Director, Patent and Trademark Office	28-06-2010
6	Limelight v. Akamai (Akamai III)	Limelight Networks, Inc.	Akamai Technologies, Inc., et al.	02-06-2014
7	Alice v. CLS Bank	Alice Corporation PTY. LTD.	CLS Bank International et al.	19-06-2014
8	BuySAFE v. Google	BuySAFE, Inc.	Google, Inc.	03-09-2014
9	DDR Holdings v. Hotels.com	DDR Holdings, LLC	Hotels.com, L.P., et al.	05-12-2014
10	Akamai v. Limelight (Akamai V)	Akamai Technologies, Inc., et al.	Limelight Networks, Inc.	13-08-2015
11	Enfish v. Microsoft	Enfish, LLC	Microsoft Corporation, et al.	12-05-2016
12	McRO v. Bandai	McRo, Inc. DBA Planet Blue	Bandai Namco Games America, Inc., et al.	13-09-2016
13	Amdocs v. Openet	Amdocs (Israel) Limited	Openet Telecom, Inc., Openet Telecom Ltd.	01-11-2016
14	Medgraph v. Medtronic	Medgraph, Inc.	Medtronic, Inc.	13-12-2016
15	Lily v. Teva	Eli Lilly and Company	Teva Parental Medicines, Inc., et al.	12-01-2017

The first was Gottschalk v. Benson, where it was decided that a *"method for converting numerical information from binary-coded decimal numbers into pure binary numbers, for use in programming conventional general purpose digital computers, is merely a series of mathematical calculations or mental steps, and does not constitute a patentable process"* (Gottschalk v. Benson, 1972). The implementation of an abstract idea into a computer-implemented method, according to this case, did not constitute patent eligible subject-matter. In this case, Benson filed a patent application which was rejected in examination after which an appeal case was filed, with two subsequent courts where the patent was eventually granted. Gottschalk then filed a petition of writ to the Supreme Court in which the validity of the patent was argued

against, and won the case. A second case on which *Alice* was based, was Parker v. Flook, which led to the assertion by the Court that a "*mathematical formula for computing alarm limits in a catalytic conversion process"* was patent ineligible (Parker v. Flook, 1978). This decision, wherein Flook followed roughly the same procedure as Benson, constituted that an invention that makes use of a mathematical formula must be novel and inventive with respect to its implementation, notwithstanding the possibility that the algorithm might be inventive in its execution. This entails that a computer-implemented invention realising an improvement on the execution of a program, while maintaining the same physical effect, is not patent-eligible as the computer-method must be seen as comprising the state of the art. These two decisions, along with Diamond v. Diehr, formed the 'patent-eligibility trilogy', which led to the creation of the machine-or transformation test (Ruggiero, 2015). The last case of the patent-eligibility trilogy was Diamond v. Diehr, where the decision was made that a computer program function to a physical process to be executed was not excluded of patentability under U.S. law (Diamond v. Diehr, 1981). The latter decision would translate into a handle to which software patents were eligible for patenting as a physical process as executed by a computer implemented system, providing it meets the regular requirements, would allow for patentability. However, this decision was a careful broadening of the earlier, strict decisions on patent-eligibility, the use of Diamond v. Diehr stipulates that the computer-algorithm should not necessarily be comprised as being state of the art, but rather should not influence the patentability of the rest of the subject-matter. The decision only stated that the mere presence of a computer-method should not immediately render the other characteristics, that might be novel and nonobvious, patent ineligible.

As mentioned, the above three decisions form the machine-or-transformation test, which implies that a process claim *"should be implemented by a particular machine in a non-conventional and non-trivial manner or should transform an article from one state into another"* (Quinn, 2010). The result of this test is the requirement of physical alteration of an object, albeit an article or the functioning of a physical machine. This test captures the combination of the above decisions and require an invention to have a physical effect, even if it is implemented in a computerized system. The limitations of this test to the patent-eligibility of computer-implemented inventions were very strict.

In addition to the above, Alice was also decided by consideration of Bilski v. Kappos, where it was decided that a method for hedging price fluctuation risks was not patent eligible as it constituted merely an idea that was implemented into a computer system, which looks to be in line with the abovementioned machine-or-transformation test (Bilski v. Kappos, 2010). However, an important connotation in this case was the rejection of the machine-or-transformation test as the only determinant in a patent eligibility process. The Court specifically indicated that an improvement on a computer system, even if it does not constitute the execution of a physical process, is patentable. This was the point where case law seemingly shifted towards favourable terms for software-patents. However, with the introduction of Allice v. CLS Bank, that changed.

Alice Corporation v. CLS Bank International is a Supreme Court decision on the patent eligibility of a patent holding computer-implemented claims. The patents that were held by Alice, on which CLS Bank allegedly infringed, concerned themselves with a computer-implemented method of hedging risk by means of an escrow mechanism. Founded in the fact that such a method existed for a long time, the patented method of performing this (known) method on a computer was considered not to constitute patentable subject-matter (Alice Corp. v. CLS Bank, 2014). This decision, in combination with Bilski v. Kappos, was a fundamental decision in the patentability of patents and provide a barrier to the patentability of Blockchain inventions that manifest them in an intangible manner. Merely following the aforementioned decisions, one would conclude that Blockchain technology applications do not constitute patent-eligible material, unless they specifically disclose a novel and nonobvious manner of attaining a physical effect. With special consideration to Bilski v. Kappos and the rejection of the machine-or-transformation test as the only indication of patentability, it is conceivable that a Blockchain technology application is patentable under the prerequisite that the implementation of the transactional system adds an identifiable benefit to the

state of the art. If the invention includes novelty and non-obviousness due to the appropriation of the transactional system, it might be patent-eligible. The result of *Alice* was a significant drop in patent grants, in the end of 2015. Research into the granting rate of patens for the courts shows that the invalidation rate in the two years after *Alice* were extraordinarily high, showing the effects of the decision on the patent-eligibility in United States intellectual property law (Tran, 2016).

In addition to the above, State Street Bank & Trust Co. v. Signature Financial Group, Inc., a case presented before the United States Court of Appeals for the Federal Circuit was decided in 1998. This decision referred to the patent-eligibility of business methods, and held that the possibility for a granted patent regarding a business method was dependent on the presence of a *"useful, concrete and tangible result"* (State Street Bank v. Signature Financial Group, 1998). The decision in this case substantiated the model created by the patent-eligibility trilogy.

The decisions as described in the above section occurred in concurrence with a series of cases between Akamai Technologies, Inc. and Limelight Networks. Over five notable decisions, they formed the foundation of case law with respect to joint infringement. The most important decision was by the Supreme Court of the United States, also called Akamai III, where it was decided that Limelight (appellant) was not liable for infringement of the patent by Akamai through joint infringement (Limelight v. Akamai, 2014). This put a stop on the earlier decision by the Federal Court of Appeal wherein the decision was made that joint infringement could be attributed to a liable 'inducer' of the infringing action. What this entails is that the joint infringement no longer needs one infringing actor to perform all the infringing steps but rather a single infringing 'inducer' who leads separate actors to the non-infringing partial actions. Naturally, Limelight Networks appealed this decision at the Supreme Court, where a unanimous decision was made that the transfer of liability requires a single actor performing all of the tasks necessary to infringe the patent, thereby ending the almost two years of 'induced infringement'.

During the developments of Akamai III, another case was handled by the U.S. Court of Appeals, BuySAFE v. Google. BuySAFE held a patent referring to guaranteeing safe transactions in an online network of which Google was accused to be an infringer. The district court granted Google's motion for claim invalidity, which was affirmed by the Federal Court of Appeals (BuySAFE v. Google, 2014). Both courts deemed, referencing to *Alice* that the subject-matter of the alleged invention was not patent-eligible. This case was yet another example of the restrictive capacity of *Alice*, which was decided only two-and-a-half months earlier. The claims of BuySAFE's patent held one method claim, followed by one computer readable medium claim for executing said method. As this disclosed only an effect in a computer-system, it did not fall within the scope of patent-eligible material under *Alice*. The Court decided that the transactional measures that were being taken would not have been patentable outside of a computer-system as the notion of safe transactions exists outside of such a system, after all, this has been a topic for centuries and the main source of existence for banks, insurers, and in part governmental institutions. While the decision logically follows from the abovementioned decisions, this case does yet again affirm the difficulties of patent-eligibility of inventions with regard to computer-implementation.

In the end of 2014, just over three months after the BuySAFE v. Google decision, the first decision after *Alice* in favour of the patent-eligibility of software patents was made by the Court of Appeals for the Federal Circuit. In DDR Holdings v. Hotels.com, the validity of computer-implemented subject-matter of the patents held by DDR Holdings was confirmed by the District Court and then affirmed by the Court of Appeals (DDR Holdings v. Hotels.com, 2014). The Court decided in favour of DDR Holdings as a result of their judgement that the subject-matter of the patents by DDR Holdings was distinctive from the subject-matter of the tried cases in the above decisions. The basis for their argumentation was the fact that DDR Holdings did not use the online network on a known procedure or a business method (Holoubek, 2014). The invention proposed a solution to a technical problem and the presence of the software, or online

network played no role in determining the novelty or obviousness of said solution. The underlying idea of the solution did not already exist, which led the Court to decide in favour of DDR Holdings.

The second time that the United States Court of Appeals for the Federal Circuit ruled in favour of the patent-eligibility of software patents was in the case between Enfish, LLC and Microsoft Corporation. Enfish appealed an earlier District Court decision on the invalidity of the patent in an infringement suit against Microsoft (Enfish v. Microsoft, 2016). The Federal Court of Appeals reversed the District Court's decision with respect to the validity of the subject-matter of computer-implemented subject-matter. As the patent by Enfish held an improvement of computer capabilities as opposed to an abstract idea as implemented on a computer (see e.g. *Alice*), the subject-matter was eligible for patentability with respect to the above cases. Since an improvement on the functionality of a computer could constitute an improvement on technology, and as such the solution to a technical problem, Microsoft was deemed to be infringing on Enfish's patent.

Another example of the *Alice* test being used in favour of patent-eligibility of computer-implemented inventions is McRo v. Bandai Namco Games America, where again a District Court ruling was reversed by the Court of Appeals for the Federal Circuit (McRo v. Bandai Namco Games America, 2016). As was done in *Enfish*, the Federal Circuit considered the patent-eligibility of the patent by McRO to be dependent on whether the claimed subject-matter constituted an improvement on an earlier system, rather that the mere implementation of subject-matter in a computerized system. McRO had developed software for automatically animating lip synchronization and facial expression of animated characters (United States of America Patentnr. US6301576B1, 1997). This patent was decided to be an improvement on technical problems with the identification of facial expressions in the state of the art, the fact that the improvement on the ability to do so was computer-implemented showed not to be a barrier to patentability as long as the invention achieves a desired effect by some other novel or nonobvious measure than the mere implementation on a computer system.

Yet another case that went against the ruling of *Alice* was Amdocs v. Openet Telecom, wherein Amdocs appealed a District Court decision ruling against the validity of four patents by Amdocs, of which Openet was accused to be infringing (Amdocs v. Openet, 2016). The Court of Appeals found the use of *Alice* in the determination of the patent-eligibility of Amdocs' patents difficult and used a comparison method with other claims in cases similar to the above to determine the patent-eligibility. However, it decided on reversing the District Court's decision nonetheless. The case is specifically worth mentioning as the 'abstract idea'-test from *Alice* did not yield a positive result, albeit because of non-applicability, and yet the Federal Court decided on the validity of the subject-matter of the patents of Amdocs. Amongst other, DDR Holdings v Hotels.com was recited as a source for the decision, showing that these cases have started attaining a degree of traction as citable case law for the Federal Court.

Referring back to the Akamai cases and the issue of joint infringement, two cases are worth noting in the wake of the decision in the Supreme Court decision of Akamai III, Limelight v. Akamai. Medgraph v. Medtronic is a decision by the U.S. Court of Appeals for the Federal Circuit, which decided that Medtronic did not infringe two patents, held by Medgraph as the joint infringement that was necessary to attribute full liability of infringement to Medtronic was not applicable as the defendant did not control the actors that took the partially infringing steps, or induced the infringement in those actors (Medgraph v. Medtronic, 2016). The Akamai cases require direct infringement of the third-party infringers. The main cause for this decision was the way in which the claims of the patents of Medgraph were written. As these were written in such a way that infringement required, by definition, two or more actors to perform actions, joint infringement is a requirement in any infringement suit. To attribute the actions of a third party to the defendant requires the application of the test from the Akamai cases, which requires the actors to form a controlled group under the defendants, which in this case was not applicable. Regarding

the patent of Medgraph, if the claims were written in such a way that infringement required only one actor, the outcome of this suit might have been different (Rogers, 2017).

The second case referring to the Akamai cases, as above, is a lawsuit between Eli Lilly and Company ("Lilly") and Teva Parenteral Medicines, App Pharmaceuticals LLC, Pliva Hrvatska D.O.O., Teva Pharmaceuticals USA, Inc., and Barr Laboratories, Inc. ("Teva"), wherein the U.S. Court of Appeals for the Federal Circuit decided that Teva infringed on the patent owned by Lilly (Lilly v. Teva, 2017). While the Court identified the infringement to have taken place and it to be attributable to the defendants, the Federal Court affirmed the District Court's Decision that no single actor performed all infringing steps. The steps as identified in the last Akamai case have been applied to test the possibility to consider the defendant liable for the joint infringement of the actors involved in the infringing procedures. Following this test, it was concluded that while joint infringement was at hand, the defendant was liable for the infringing actions, notwithstanding the fact that no legal contract was in place, indicating what those actions should be. The actors were required for the execution of the invention and the manner and timing of the performance had been established by the defendants.

These last two cases point towards an overarching conclusion with respect to joint infringement. Following the Akamai cases, joint infringement is attributable to a single infringing party only if the third-party activities are a condition for the execution of the invention and the manner and timing of the performance is established by the patented method. Referencing to *Medgraph*, these conditions were not met as one of the third-party infringing actors were patients, that were considered not to be controllable with respect to the invention at hand. In *Lilly*, however, the procedures were controlled by the inventions with respect to the Akamai V test (which was broadened as opposed to Akamai III) (Akamai v. Limelight (V), 2015). With regard to the above cases, from *Akamai*, to *Medgraph*, and *Lilly* it can be seen that joint infringement comes down to the controllability of actors that execute the invention, which is subjective, even when applying the test from *Akamai V*. The resulting best practice with consideration of these cases would be to direct claims at individual actors, so as to prevent joint infringement. Should this not be possible, due to requirements under, for instance, *Alice* and subsequent cases, the claims should be directed at actors that are controllable with as little ambiguity as possible. The inclusion of an actor such as a 'patient' is too broad as it allows the Court to argue that it is not possible to assert control over the entire population of a jurisdiction, who all can become a 'patient'.

The remaining cases in the above section, with regard to patent-eligibility of computer-implemented subject-matter allow the conclusion that to patent a Blockchain invention, the subject-matter must not solely refer to an abstract idea but to an inventive concept as well (DiNizo, 2018). Ideally, the inventive concept can be implemented in the claims of the invention without the use of multiple actors so as to prevent the possibility of subjectivity in litigation with respect to joint infringement. An important consideration in the above cases is the use of a computer-implemented system as a tool for the invention, rather than the reason for the inventiveness, as is clear from *DDR Holdings* and *Enfish*. Although *Amdocs* shows a tendency towards a more lenient approach to patent-eligibility of computer-implemented inventions with the lack of use of the *Alice* test, this is not an indication that this will progress over the coming years, especially not in Supreme Court decisions.

6.2.2 Case Law in Europe

The European Patent Office holds a wide array of decisions, predominantly by their Legal Board of Appeal, Technical Board of Appeal, and the Enlarged Board of Appeal. With regard to the patentability of Blockchain inventions, the most important decisions will be by the Technical Board of Appeal, as these are leading for the determination of patent-eligibility of subject-matter of Blockchain technology applications. The most decisions by the Technical Board of Appeal, and one opinion by the Enlarged Board of Appeal are shown in the below table. These will briefly be discussed in the following section. It should be noted that the patent-eligibility of European law and United States law is similar, and the overlapping case law will not be discussed quite as lengthy as the United States case law was discussed in the above section.

Table 15 - European Case Law for Analysis

#	Case Number	Applicant	Headword	Decided
1	T 1173/97	IBM Corp.	Computer program product/IBM	01-07-1998
2	T 0935/97	IBM Corp.	Computer program product II/IBM	04-02-1999
3	T 641/00	COMBIK GSM AB	Two identities/COMVIK	26-09-2002
4	T 258/03	Hitachi, Ltd.	Auction method/HITACHI	21-04-2004
5	T 0424/03	Microsoft Corporation	Clipboard formats I/MICROSOFT	23-02-2006
6	T 0154/04	DUNS LICENSING ASSOCIATES, L.P.	Estimating sales activity/DUNS LICENSING ASSOCIATES	15-11-2006
7	G 0003/08	N/A	Programs for computers	12-05-2010
8	T 1286/10	Hitachi Solutions, Ltd.	Detection and correction of false descriptions in IUB code input data for linkage disequilibrium genotype analysis	29-11-2016

The first case that is relevant to the patentability of subject-matter referring to software is T 1173/97 of the Technical Boards of Appeal of the European Patent Office. It concerns an appeal to a refusal for patentability of a patent appropriated by IBM Corporation. The objection by the Examining Division referred to claims that, according to the Examining Division, contained a computer program as such, which under Article 52(2)(c) and 52(3) EPC is not patentable subject-matter. Because the subject-matter of the invention, when executed, provided a *"further technical effect which goes beyond the 'normal' physical interactions between program (software) and computer (hardware)"*, the subject-matter was deemed not to be excluded from patentability by the Technical Board of Appeal, thereby reversing the decision of the Examining Division (Computer program product/IBM, 1998). This was the first favourable decision of the boards of appeal that allowed the patentability of computer programs, regardless of their contents. In reference to this case, it is understood that a 'computer program as such' as referred to under article 52(2)(c) and 52(3) EPC has the meaning of a *"mere abstract creation, lacking technical character"* (Rodés, et al., 2016). Similar to the requirements to patentability under *Alice* as mentioned above, the mere implementation of an idea into a computer does not constitute inventiveness but merely comprises an expression of the idea in another embodiment. The technical character of the computer-implemented invention must not be put aside. In addition to the requirements of a technical effect the subject-matter of an application should contain 'further technical effects', meaning that even though the application of an existing technology to a computer involves technical considerations, the implemented system must add to the previously existing technology. This is essentially the same as the considerations made under the patent-eligibility trilogy and subsequently under *Alice*. Following T 1173/97 in 1998 another decision was published by the Technical Board of Appeal on the same subject in 1999. T 0935/97 wherein the Board found the mathematical method for the acclaimed invention, namely that of data processing for displaying information was granted preliminary allowance for patentability. Following the board, the *"exclusion of computer program products from patentability is not applicable under all circumstances"* (Computer program product II/IBM, 1999).

Under the previously discussed two decisions, specifying the need for a further technical effect in the determination of patent-eligibility, the inventions that are investigated in accordance with this method have, by definition, features that are essentially non-technical. The need for a technical effect besides the implementation into a computer-system, implies that said implementation is a non-technical feature with respect to the patent-eligibility for inventiveness requirements. The differentiation of technical and non-technical features in the assessment of patent-eligibility is exemplified in T 641/00, in an opposition procedure between COMVIK GSM AB and DeTeMobil Deutsche Telekom MobilNet GmbH. If non-technical features are in the claimed subject-matter, even though the claimed subject-matter has technical character as a whole, the claimed subject-matter must be tested for inventiveness according to the technical features alone (Two identities/COMVIK, 2002). The non-technical features (i.e. those features that do not contribute directly to the technical character) cannot be considered in the assessment of inventive step. That being said, the claimed subject-matter must have technical character as a whole, before the inventiveness is determined according to those features that contribute to this technical effect. Referencing to Blockchain technology, this would entail that the mere application of a Blockchain system to an existing method or process would not contribute to the assessment of inventive step, even if it shows technical character as a whole. After all, following T 1173/93 and T 0935/97, the implementation of the system in a Blockchain network would not constitute a 'further technical effect' as necessary for inventive step determination. This explanation of the need for a further technical effect and its application in the determination of inventive step, notwithstanding the need for a technical effect as a whole, is further substantiated in T 258/03, an appeal by Hitachi following the refusal of the claim in its patent during prosecution. Even if a method were to be implemented on a computer system, as was done by Hitachi, the possibility exists to attain a granted patent due to the technical character of the implementation of the system, if it solves a technical problem (Auction method/HITACHI, 2004).

The methodology of T 258/03 was expanded under the 2006 decision in T 0424/03 in an appeal filed by Microsoft for a patent concerning data transfer with expanded clipboard formats. This decision distinguished nature of a computer-implemented method from a computer program. It was determined that a method for operating a computer program, constituted a series of steps aimed at achieving a technical effect (Clipboard formats I/Microsoft, 2006). Because a computer-implemented method is different from a computer program, it does not constitute subject-matter excluded from Article 52(2) EPC (Art. 52 EPC, 2016). In determining the decision for this case, the board refers to T 258/03 and its statement that a method constitutes a patentable invention if it has technical features with the meaning of T 1173/97 and T 0935/97. In addition, the board states that subject-matter disclosing a computer-readable medium also constitutes patentable subject-matter as it relates to a technical product. If a technical objective is achieved by means of either a method implemented on a computer or by a computer-readable medium, the subject-matter is considered to be patentable.

The above leniency with respect to the allowance of computer-implemented methods to circumvent the non-technical character and thereby being eligible for patent protection is strongly countered in T 0154/03, where a decision is made against the application of Article 52(2) by the Court of Appeal of England and Wales in their decision on Aerotel v. Telco, wherein the patent by Aerotel was found valid despite strong objections with respect to the allowability of the claimed subject-matter (Aerotel v. Telco, 2006). In T 0154/03, this was strongly criticised as being *"irreconcilable with the European Patent Convention"* (Estimating sales activity / DUNS LICENSING ASSOCIATES, 2006). The apparent ease with which the Hitachi and Microsoft cases were allowed patent-eligibility was pushed back by the decision in the Duns Licensing Associates case. However, in the pleadings, a specific request for an opinion of the Enlarged Board of Appeals was requested with respect to the following question:

> *"3(a) Is an operative computer program loaded onto a medium such as a chip or hard drive of a computer excluded by Article 52(2) unless it produces a technical effect, if so what is meant by 'technical effect'?"* (T 0154/03, p. 8, s. V.3a)

What followed was an opinion by the enlarged board of appeal on the subject of programs for computers in which this question was addressed. The Board states that the definition of a 'computer program' is assumed to be equal to the definition of 'program' or 'software' and 'program for a computer' (Programs for computers, 2010). As such, the Board argues that cases where the subject-matter holds synonyms for the above definitions, even in reference to method claims for said synonyms, the subject-matter is excludable from patentability only if there is no specific reference to the technical effect that the implementation of such a system or method could induce:

> *"In the view of the Board, a computer program claimed by itself is not excluded from patentability if the program, when running on a computer or loaded in to a computer, brings about, or is capable of bringing about, a technical effect which goes beyond the 'normal' physical interactions between the program (software) and the computer (hardware) on which it is run."* (G 8/03, p. 27, s. 10.2.1)

Furthermore, the Board is of the opinion that the general attempt to conform to patent-eligibility by applicants by including a 'computer-readable medium' as a technical physical feature does not automatically lead the invention to being patent-eligible. In light of the demand for a 'further technical effect', even though the invention may have technical characteristics, the non-technical feature cannot be weighed in the discussion of inventiveness. As such, the determination for patent-eligibility by inclusion of a 'computer-readable medium' leads to a consideration of the inventiveness of only the physical features, without taking into account the effect that the computer program has on that computer-readable medium, i.e. the technical effect must go beyond the 'normal' physical interactions between software and hardware. The discrepancy between the outcomes of T 613/85 and T 190/94 on the one side and T 125/01 and T 424/03 on the other side, providing basis for the request to referral to the Enlarged Board of Appeal, refers to the need for the technical effect to apply to a physical entity in the real world. The Board takes no position in answering this question (see T 0154/03) as it argues there is no basis for the divergence identified in the question with reference to the need for a technical effect in the real world. As by the above argument, the technical effect might be achieved in a computer program, if and only if the program brings about a technical effect as in the above quotation. This is clearly in line with the decisive U.S. case law, wherein it has been determined that the mere technical consideration necessary to apply a method or process to a computer program is not patent-eligible, even though it has technical character.

A more recent decision regarding the topic of patentability of computer programs is T 1286/10, again for the appropriation of a patent of which the application has been rejected by the Examining Division. Hitachi Solutions Limited once again produced an alleged invention utilizing computer-implemented method that was deemed to be patent-ineligible under multiple provisions of the EPC, amongst which Article 52(2). The Board's decision set aside the judgement of the Examining Division by stating that the technical features of the application used to determine inventiveness do not fall within the scope of said article as they achieve a technical effect that surpasses the mere interaction between software and hardware, thereby substantiating the aforementioned decisions. These decisions seem to be in line with the decisions made in T 641/00, T 258/03, T 0154/04 and T 0154/04 (Hitachi genotype analysis, 2015).

The implications for the patentability of Blockchain applications under this opinion is in line with earlier concluding remarks, of U.S. case law albeit with the exclusion of the issue of joint infringement (Liotard, 2006). A key take-away is the need for a further technical effect as shown in the IBM cases. It follows from the opinion of the Enlarged Board of Appeal that the discrepancy between the four cases that led to the referral of question 3(a) concerning the need for a technical effect to be attributed to a physical feature 'in the real world' is merely attributed to the existence of a further technical effect that goes past

the general interactions of the software with the hardware of a computer program. A Blockchain technology patent application should therefore refer to a technical effect that surpasses the technical character of the implementation of a method or process in a computer program. Furthermore, in assessing the inventiveness of an invention, the application of the technology to the Blockchain network itself will be considered to be a non-technical feature with the meaning of Article 54 EPC. As such, the inventive step must be assessed using the technical features apart from the application of Blockchain technology.

The difference between the patentability of Blockchain technology applications in the United States and Europe, generally, might be attributed to the difficulties resulting from *Alice* and the decisions on which that decision was based. As mentioned, the above U.S. cases separate issues surrounding joint infringement and patent-eligibility of subject-matter of software-based patent applications. When formulating the claims for a patent, taking into consideration the above reasoning on joint infringement (i.e. claims must be actor-specific so as to prevent joint infringement issues), the resulting claims might not be in line with the aforementioned machine-or-transformation test. The implementation of the machine-or-transformation rule in the United States implies that the subject-matter must comprise both a physical entity, or a process for transforming said entity, in combination with the computer-implementation of said process. This applies pressure on the claim formulation of a computer-implemented invention from two sides; either create claims that are eligible for joint infringement, and as such a higher uncertainty in litigation, or create claims that are likely to be patent-ineligible. The high rate of cases in the United States is partly attributable to this effect, while in Europe, there has not been a high degree of joint infringement cases because of the absence of a machine-or-transformation test. As such, the patentability of computer-implemented programs, while not necessarily having a higher granting rate, needs no two actors in one claim.

6.2.3 Claim Formulation – Guidelines for Claim Development

Claim formulation in Blockchain technology patent application is prescribed by the European Patent Office in part, as it has a set of Guidelines that are generally followed in the process of drafting (see Appendix D). This section will provide a brief run-through of these guidelines, which are based on prevalent case law of the Technical and Enlarged Boards of Appeal. Following the guidelines on claim formulation with respect to disclosure of technical features, all features that aid to the achievement of the technical effect to which the invention is subjected to the inventiveness test must be disclosed in the claim. Specifically, in Part F, Chapter IV, Section 3, Paragraph 9, the distinction is made between *"inventions in which all the method steps can be carried out by generic data processing means"* and *"inventions in which at least one method step requires the use of specific data processing means or other technical devices as essential features"* (EPO (F.IV.3.9), 2017). Linked to the distinctions made in section 4.1, the technology wherein the transactional system is not novel, but the implementation of the technology achieves a technical effect are covered by the former. Technologies that show an improvement on the transactional body of the distributed ledger are comprised by the latter. Referencing to a number of decisions that have been elaborated on in the above section (e.g. T 424/03, G 3/08, T 1173/97), the first category of computer-implemented inventions is usually identified as beginning with a method claim, as confirmed in section 6.1.3 with following claims usually referring to said method claim, those following claims consisting of *"apparatus/device/system claims"* followed by *"computer program [product] claim"*, and *"computer-readable [storage] medium/data carrier claims"* (EPO (F.IV.3.9.1), 2017).

Since Article 84 EPC confers the requirement of the claims to be clear, the claim formulation in the case where the invention cannot be carried out by means of conventional data processing means, the claims must comprise the additional technical devises necessary for data processing or execution of the invention. In the case of Blockchain technology applications, should the technology need an external sensor with which the system should communicate to acquire the necessary result in the execution of the invention, theses must be included in the independent claim.

6.3 Summary of Validation of Theoretical Decision-Making Framework

This chapter has provided the validation of the theoretical decision-making framework as proposed in chapter 5, first by using data-based patent analysis and subsequently by reviewing case law and guidelines. This has resulted in the framework as described in the above sections.

The data-based improvements were performed by analysing the granting rate in certain the jurisdictions where the presence of Blockchain technology applications is largest. These results have shown the jurisdiction most likely to grant a patent on Blockchain technology is South Korea, followed by Australia, the United States and Japan. Furthermore, the same jurisdictions have been analysed for software patents, which were the centre of disputes on patentability as well, about two decades ago. The difference in granting rate between Blockchain technology patents and software patents show a significant decrease of South Korea, while Taiwan, the United States of America, the China People's Republic and Japan show an increase between 25% and 45%. Summarizing, currently, South Korea is a good starting point for obtaining a granted patent. This is likely to change to the US, China, Taiwan and Japan over the coming years. The European Patent Office, while showing a large increase when looking at software patents, has an extremely low granting rate for Blockchain patents and still provides a lower than average granting rate for software patents, indicating that the appropriation of European Blockchain patents will be difficult. The above provides the answer to sub-question 4A.

The patent analysis was first performed to determine what part of the technology is included in the subject-matter of granted Blockchain patents. This showed that there is no conclusive evidence as to what the best strategy is regarding the part of the technology that should be patented. However, the binary approach to this analysis resulted in another finding, namely that all granted patents seem to describe only the functionalities of a transactional system necessary to exemplify the non-obviousness and novelty of their invention without limiting the scope of the patent protection. This coincides with the conclusion of section 2.2.2.2 that the dimensions of the consensus mechanism of the distributed ledger as shown in figure 9 are not mentioned in a granted patent as this would severely limit the scope of protection. The part of the Blockchain technology that is included in the subject-matter of the patent is only that which is necessary to allow the patent to be granted, without exemplifying the entirety or the nature of either the technical effect or the distributed ledger, which answers sub-question 4B.

The third part of the patent analysis pertains to claim formulation and shows that the preambles of most granted Blockchain patents use a method claim, followed by a system claim. In addition, many granted patents show a preference for a computer storage medium to be included in the claim as well. All transitional phrases, as was to be expected, were open. The answer to sub-question 4C would therefore indicate that a method-claim or system-claim, followed by possibly a computer storage medium claim are beneficial for a granted patent, with an open transitional phrase.

The second section of chapter 6 concerns itself with improvements on the theoretical model by analysis of case law from the United States and Europe. Starting with the United States, specifically from *Alice*, three decisions have been decided as being fundamental drivers for the field of patent-eligibility of software or computer-implemented inventions. *Gottschalk*, *Parker* and *Diamond* formed the patent-eligibility trilogy by formulating the machine-or-transformation test, which requires the physical alteration or implementation into a physical device by the invention. Although *Bilski* rejected the machine-or-transformation test as the only determinant for the patent-eligibility of an invention, the requirement remained the creation of a useful, concrete and tangible result, as confirmed by *State Street Bank*. This led the Supreme Court to rule in favour of CLS Bank in *Alice*, based on the argumentation that the alleged invention only conveyed a known method in to a computer-implemented system. The effects of *Alice* were immediately visible, for instance in *BuySAFE*, where again the argumentation was that the alleged invention held the computer-implemented version of an idea that already existed without the computer-system and the implementation in said system would not yield a technical and tangible result.

What followed was a spectacular drop in granted patents in the field of computer programs. However, in a number of cases the Courts ruled in favour of the computer-implemented invention, namely *DDR Holdings*, *Enfish*, *McRO* and *Amdocs*. In these cases, the Courts ruled in favour of the invention for either one of two reasons. First, the invention could propose an improvement of computer capabilities and as such solve a technical problem, in contrast to applying a general data processing means to an existing idea (*Enfish*). Second, the inventions could propose a solution to a technical problem, which is inventive and novel, regardless of the presence of a computer-program (*DDR Holdings*, *McRO* and *Amdocs*). In other words, as stated in *McRO*, the fact that the improvement was executed on a computer was no barrier to patentability.

On the subject of joint infringement, the string of cases between Limelight Networks and Akamai Technologies are leading. The most important being *Akamai III*, which was subsequently broadened by *Akamai V*. These cases stipulated the requirements for joint infringement as being that the activities of a partially infringing third party must be conditional to the execution of the invention and that the manner and the timing of these actions must be established by the patented method. This was shown in *Medgraph* and *Lilly*, where the tests for joint infringement were performed per the description of *Akamai V*.

In European case law, the above cases show the need for a 'further technical effect', which does not necessarily refer to the invention being applicable in the real world, or even in a physical entity as shown in T 1173/93 and T 0935/97. However, while the implementation of an invention into a computer-program has technical character, it cannot constitute a further technical effect if it does not go beyond the general interactions between software and hardware, following T 641/00 and T 258/03 and T 0424/03.

After a strong push-back for patent-eligibility of computer programs in T 0154/04, the Enlarged Board of Appeal published an opinion in which much of the issues regarding the patentability of computer-implemented inventions are addressed. In G 3/08, the need for a physical effect in the real world is discarded, while the requirement of a technical solution to a technical problem that goes beyond the generic interactions between hardware and software is stipulated clearly. This is confirmed in T 1286/10, where a patent is granted because it provides such a 'further technical effect' beyond the general hard-software interactions.

Concluding, both in the United States and in Europe, an invention is considered to be patent-eligible if it comprises a technical effect that is more than the inclusion of a general process into a computer program. While in Europe identified as 'further technical effect', the United States notion that an abstract idea is not inventive when applied to a computer program conveys a similar requirement of the subject-matter. In the United States, a trade-off between joint infringement and patent-eligibility is created as the inclusion of a physical entity in the subject-matter is likely to help in dealing with the requirements from *Alice*, while this could induce multiple actors being necessary for infringement, which could lead to negative results in litigation.

In both jurisdictions, claims must therefore be drafted in such a way that they convey the full technical effect, preferably showing a technical solution to a technical problem, often by inclusion of a method-claim. This technical solution may preferably refer to a physical entity or the alteration of said entity but can propose a technical improvement to a computer-system as well. Further, claims must be drafted in such a way that a single actor can execute all steps in the claim. If this is not possible, regard should be taken to the controllability of the actors involved in the execution of the invention so that the actions are conditional to the execution and the manner and timing in which they are executed are controlled. Finally, these actors should be credibly regarded as controllable and should therefore be specified in terms of their characteristics or the characteristics of the actions they perform.

7 Conclusions and Discussion

"If there is anyone whom I have not insulted, I beg his pardon."

– Johannes Brahms –

This chapter is divided into two main components, the conclusion, which will answer the research questions, and the discussion, wherein the limitations to the research and considerations for future research will be provided.

7.1 Conclusions

This section will provide an answer to the research questions, by summarizing the above chapters. After which an answer to the main research question is provided, by identifying the considerations in the various strategic options identified in the research. A long-term recommendation will be provided, both for regulatory bodies as well as for the professionals tasked with applying the resulting regulations. Further, additional considerations that have not been discussed while addressing the research questions will be elaborated on.

As described in section 1.3.2, the objective of this research should be accomplished by answering the following research question:

> *How can a validated decision-making framework be constructed for protecting intellectual property of Blockchain technology applications, using current intellectual property law, given key characteristics of the Blockchain applications of which the intellectual property rights must be protected?*

The answer to this question is provided by answering a set of sub-questions, which will be discussed in the following sections, by summarizing sections of the above chapters. For an explanation of the research question and its sub-questions and how they contribute to the achievement of the research objective, reference is made to section 1.3 of chapter 1.

7.1.1 Answer to Sub-Question 1

The first question to be answered in the process of achieving the research objective concerns itself with what type of intellectual property right is suited to protect the intellectual property of Blockchain technology applications. The answer to this question can be identified by careful consideration of the law, technology and the literature surrounding both topics and the combination of both topics. To determine the types of intellectual property right that can protect the intellectual property of Blockchain technology applications, the technology must be split in parts suited to specific rights. As discussed in section 4.1, the technology can be split into three parts, the first being the fundamental layer of the technology wherein consensus is reached over transactional data, the Distributed Ledger. The second part is the smart contract that determines what the 'rules' are of the transactional measures in a Blockchain technology. The third is the Technical Effect emanating from the application of the technology to a specific situation, thereby solving an alleged technical problem. As shown in table 6 in chapter 4, two intellectual property rights can be applied to these parts; copyright and patents. The Distributed Ledger can be protected both by copyright and patents, the Smart Contract can only be protected by copyright, and the Technical Effect can only be protected by patents. The answer to the first sub-question is twofold, both copyright and patents are able to protect the intellectual property of Blockchain technology applications.

7.1.2 Answer to Sub-Question 2

Following the above question, it is important to consider what the strategic options in the abovementioned intellectual property rights are. Firstly, based on the literature review in chapter 2, a

conclusion can be drawn on the level of strategic considerations of copyrights. Since the protection is immediate and automatic, there is little strategy involved with obtaining protection of the intellectual property through copyright. In addition to this, the protection conferred by copyright, especially with respect to computer code, is limited. Even a slight alteration of the protected matter could result in non-infringement. Per these considerations, the use of copyright as a tool for the protection of Blockchain technology applications will not be considered any further. The resulting intellectual property rights able to adequately protect the intellectual property of Blockchain inventions are patents. To answer the second sub-question, strategic possibilities in the two remaining layers of the technology (Distributed Ledger and Technical Effect) are determined. These choices are categorized in threefold; the filing route, the part of the technology to be protected (i.e. the patent-eligibility of both layers), and the claim formulation of the claims conferring the invention. These choices can be seen in figures 14, 15 and 17 in chapter 4 but will be briefly summarized.

The filing route concerns itself with the determination of the optimal way in which to apply for patent-protection in various jurisdictions. Starting from the countries in which patent protection is needed, a consideration can be made as to whether a regional intermediation by a regional patent office is possible and preferred. If the intermediation of the regional patent office is possible and preferred, the same consideration can be made for intermediation of a global filing route of the Patent Cooperation Treaty. Finally, these choices can be expanded by the possible addition of a filing in a jurisdiction where the right to priority is attained by which the considerations of all other jurisdictions can be extended for a year.

The part of the technology is concerned with the patent-eligibility of the two abovementioned layers of the Blockchain technology application that are theoretically patentable. Depending on the patent-eligibility of the Distributed Ledger and the Technical Effect, either one, neither, or both layers can be chosen for constituting the patentable subject-matter.

The formulation of claims can be structured following the claim structure as described by the WIPO, the preamble, the transitional phrase and the claim body. The preamble indicated the type of invention that is to be patented, the transitional phrase indicates the scope of protection of the claim body and the claim body described the features of the invention to be protected by the patent. The preamble confers the nature and type of invention that is to be protected. Two main types of claims can be identified, namely claims based on an action, or claims based on a physical invention. Generally, physical inventions are identified with a composition claim (when it is a product) or an apparatus claim (when it is a device). Activity claims are generally separated into method claims (in case of a process) or use claims (in case of usage of an invention). Naturally, these preambles are not necessarily limited to these four claims, as is shown in table 8 in section 4.3.3.1. The transitional phrase confers the level of specificity of the characteristics of the claimed subject-matter. If the transitional phrase is closed, all features and only those features must be identified in allegedly infringing inventions. Although this might reduce ambiguity during litigation, the benefits of keeping the transitional phrase open is that any invention containing the features of the claimed subject-matter is infringing, regardless of what additional features are present in the allegedly infringing technology. Finally, the claim body confers the claimed subject-matter and possibly the dependency of the claim on earlier claims. While some requirements for the claim body exist, no specific choices can be formulated as the contents of the claim formulation is entirely dependent on the invention at hand.

The answer to sub-question two is threefold, in the filing route, the consideration concerns the required jurisdictions where protection is needed, the possible intermediation of a regional of a global filing route and the inclusion of a priority right in one of the jurisdictions. The part of the technology to be protected is dependent on the patent-eligibility of the separate layers of the technology. In the claim formulation, a choice of preamble can be made dependent on the nature of the invention, the transitional phrase must be chosen per the specificity of the characteristics of the subject-matter to be protected and the body must confer all features to be protected.

7.1.3 Answer to Sub-Question 3

The third sub-question in the research is concerned with the effect that the characteristics of the technology and proprietor preferences have on the choices as identified under the second sub-question. These characteristics have been identified in chapter 5, during the development of the theoretical decision-making framework. Again, the abovementioned three strategic directions and the options therein have been discussed. Frameworks have been developed for the filing route, the part of the technology to be patented and the formulations of the claims.

The filing route will predominantly be determined by jurisdictional effects on the filing route, risk, and competition. The jurisdictional protection should elaborate on the regions wherein legal protection is needed for the inventions of the proprietor, based on national law and the type of infringement that is to be expected. Only commercial producers and users can infringe on patents, non-commercial users cannot. As such, the countries in which patent protection is needed are those where producers or commercial users apply the teaching as conferred in the patent. Based on the jurisdictions that emanate from these considerations, a cost- and competitor-consideration must be made. If the importance of a fast patent portfolio (due to competition) is needed, national filing might be beneficial. If not, regional or global filing routes may be a better alternative. If fast patent protection is needed in a specific country, the right to priority could be used in this country by filing immediately in said country and using the right to priority for other jurisdictions. A cost-consideration will lead to the consideration of the size of the patent portfolio, if there is a high number of countries, regional or global filing is preferred, depending on the clustering of those countries (see also figure 22).

The framework for the patentability of the beforementioned layers of the technology is concerned with the patent-eligibility of those layers. Based on national law, the patent-eligibility is determined per the requirements as stipulated in national law or regional treaties. Fundamentally, the claimed subject-matter must be new, inventive and applicable, albeit that some jurisdictions use different connotations for the determination of the patent-eligibility. Further, for jurisdictions where there is no examination, for instance in the Netherlands, the consideration should be made whether a non-valid granted patent is useful, perhaps for pitching for clients, funding acquisition or credibility. If this is the case, the invention does not necessarily need to confer to the standards for patent-eligibility as the patent will be granted regardless of these considerations.

Finally, for the answer of sub-question 3, claim formulation is analysed. Following a framework adapted from Hodes (2005), the preferred embodiment (preference by the proprietor) and the prior art are analysed to determine the patentability of the formulated claims. For dependent claims, initially formulated claims are relevant as well. These considerations lead to the development of the claims, wherein the consideration for the preamble, transitional phrase and body as presented in the previous section are determined based on the preferences of the proprietor and the nature of the invention. The assessment that the patent attorney must make in the development of the claim as shown in the middle section of figure 24 is represented in figure 25, wherein the features of the invention are listed, which are then tested per the requirement of the law through the framework of patent-eligibility of the determination of the part of the technology to be patented. From this, the patentable (combinations of) features that meet the requirements of the law arise. The proprietor preferences will then determine what the preferred embodiment for patenting the invention is.

In answering sub-question 3, the three strategic directions as presented before are considered. Influencing factors to the choices in these strategic directions are jurisdictional preference of the proprietor (based on for instance market, competition, economy, industry, etc.), risk through monetary allocation of funding for intellectual property protection, competition, patent-eligibility of the technology (i.e. the novelty, inventiveness and applicability of the technology), the law-based patent exclusions (e.g. Art. 54(2) EPC), the state of the art, and the preferred embodiments of the technology.

7.1.4 Answer to Sub-Question 4

The final sub-question, as explained in section 1.3.2, have been categorized into 5 separate questions, which will all be discussed briefly in this section. The combination of these questions will answer sub-question 4 by explaining the possible adaptations to the theoretical decision-making framework based on patent analysis, case law and guidelines of patent offices.

7.1.4.1 Sub-Question 4A

In section 6.1.1, the likely development of the granting rate of Blockchain technology-based inventions was considered by performing a patent-analysis of granted patents and applications, since 2006, that contain the words 'Blockchain' or 'Distributed Ledger' in the title, abstract of description. What was found is an extraordinarily high granting rate in South Korea of 82%, followed (but not closely) by Australia with 39%. The United States of America and Japan are above average with 28% and 25% respectively. While China, Taiwan and Germany hover around the average of 19%, the European Patent Office is much lower with only 3%. To provide an indication of the development in the patent-eligibility of Blockchain technology applications in the future, the granting rates of software in general have been researched in these jurisdictions as well so as to provide an estimate of future developments in the field of essentially non-patentable subject-matter. Software patents are granted at a much higher rate of 43%, with Taiwan (63%), the United States of America (60%), South Korea (56%), Japan (54%) and China (50%) well above this average. Germany shows an even lower granting rate for software with 13% and the European Patent Office is more lenient on software patents with 28% although still far under the average granting rate. When comparing these granting rates, a prediction can be made for the future of patent-eligibility of Blockchain technology applications. Currently, jurisdictions most likely to grant a Blockchain patent application is South Korea. In the future, it is likely that Taiwan, the United States of America and China will adopt a more lenient approach to the patent-eligibility of Blockchain technologies. A consideration could be to reserve the right to priority in South Korea, after the priority year apply for a PCT application, then file through EP and other regional offices and go to national phase as late as possible, allowing for the average granting rate to rise in the necessary countries.

7.1.4.2 Sub-Question 4B

Section 6.1.2 elaborated on the part of the technology to be patented when filing a patent application for a Blockchain-based invention. Thirty-four granted patents were analysed, out of a search result of 163 patents, of which 5 could not be assessed due to limitations of the translation mechanism. From the 29 patents left to be analysed, 15 protected the transaction system or consensus mechanisms of the distributed ledger and 19 protected some technical effect as a result of the implementation of a (known) Blockchain mechanism. While this result shows that there is no significant preference for the patenting of either the distributed ledger or the technical effect, this section provided another insight. Namely that the answer to this sub-question is 'neither'. The subject-matter of the invention should disclose the necessary features for the skilled person to execute the invention, which does not necessarily entail the binary choice between the distributed ledger or the technical effect. The distributed ledger is therefore always disclosed to a limited extend to allow the skilled person to execute the invention. However, the type of consensus mechanism or the characteristics of the transaction system are not disclosed if not absolutely imperative for the execution of the invention as that would limit the scope of protection. The part that is disclosed is that which is necessary for the execution of the invention and that which is necessary for the novelty and inventiveness requirements.

7.1.4.3 Sub-Question 4C

The claim formulation was addressed in section 6.1 as well, through analyses of the same 34 patents as in the above section, with the exclusion of two patents in both subjects, preambles and transitional phrases. As expected all transitional phrases were open so as to delimit the scope of protection conferred by the patent. The preambles that were used in these patents predominantly consist of a method claim,

followed by a system, computer storage medium or a device, thereby combining a process claim with a physical device, as is required under U.S. case law and as is suggested by the EPO Guidelines.

7.1.4.4 Sub-Question 4D

The case law that is considered in this research is twofold, case law from the United States of America and case law from the European Patent Office. The U.S. case law is started with *Alice*, which was decided upon the considerations of the 'patent eligibility trilogy', *Gottschalk*, *Parker* and *Diamond*. This trilogy created the machine-or-transformation test, which is the main reason that claims are required to have both a method and a physical claim. Based on these decisions and those that followed (see section 6.2.1), patent-eligibility is dependent on the inventive nature of the claimed invention, without the consideration of the implementation of that idea in a computer program. The mere inclusion of an abstract idea in a computer program is not enough to constitute patentable subject-matter, even though the implementation clearly has technical character. Another consideration in the United States case law is the subject of Joint Infringement, brought forward in the *Akamai* cases and followed by *Medgraph* and *Lilly*, the conclusion is that infringing actions of actors executing the invention can only be attributed to a single actor if it is reasonable that the actions performed by third-party infringers are conditional to the execution of the invention and the manner and timing in which these actions are to take place are clear. The control of a third party is only plausible if these are specified unambiguously (i.e. a general group in a population is not specified enough). To circumvent the subjective nature of joint infringement, the claims should be directed at one infringing actor. This leads to a trade-off between conformity to the case law of patent-eligibility and the case law of joint infringement. On the one hand, a claim should preferably include physical subject-matter, on the other hand, both the attribution of a physical entity and a method in one claim could more easily lead to the inclusion of joint infringement.

In European case law, the decisions of patent-eligibility are summarized in the opinion of the Enlarged Board of Appeal, G 8/03, wherein it is clearly stipulated that although the mere presence of a computer-implemented feature does not exclude subject-matter from patentability, the technical effect of said subject-matter must go beyond the general interactions between a computer-program (software) and a device (hardware). This is in line with the conclusions that can be drawn from the United States case law with the exception of the requirement of a physical feature in the subject-matter an as such a complex situation surrounding joint infringement. In European case law, the features that allow the invention to be carried out on a computer program should be considered to be non-technical features and should not be applied in the determination of the inventive step under Article 54 EPC.

7.1.4.5 Sub-Question 4E

The European Patent Office provides guidelines for claim formulation of computer-implemented inventions (see Appendix D). The distinction made in section 4.1 is followed by the guidelines, wherein an apparent distinction is made between computer-implemented inventions that provide an improvement on the way in which data is processed by existing methods and inventions where the implementation of generic data processing means constitutes a new invention, outside of the computer-implemented environment. In both situations, the guidelines confirm the conclusion drawn in section 6.1.3, wherein it is shown that most granted patents begin with a method claim, and are followed by an apparatus claim, a computer program claim and a computer-readable storage medium claim. In the case of an invention applying generic data processing means for the execution of the invention, it must be shown that the invention is inventive, regardless of the implementation of the data processing means. The case in which specific data processing means are necessary for the execution of the invention, additional claims could be required so as to confer the technical devices required for such data processing. If no additional data processing devises are necessary, the method of data processing must be conferred in such a way that the implementation of the method in a computer program does not harm the inventiveness of the invention.

The answer to this sub-question, regarding the difference between the guidelines and the theoretical decision-making framework, lies in the implementation of Art. 52(2) in the consideration of subject-matter. To circumvent this limitation, the invention must be shown to be an invention, regardless of the presence of the non-patentable subject-matter.

7.1.5 Answer to Main Research Question

The main research question cannot be answered in one sentence without including the words 'problematic', 'complex', and 'difficult'. To answer the main research question, the three strategic directions as indicated in chapter 4 will be separately discussed to explain what the theoretical and validated considerations are, what the influencing factors are and how a Blockchain technology application should be patented.

In the consideration of the strategy in the filing route of the process of patenting a Blockchain technology application, the preferences of the proprietor with regard to jurisdictions, monetary risk and competition result in a preliminary filing route with possibly a specification of priority right. Based on the granting rate analysis, the priority right should be chosen in a country where the granting rate results predict a positive result, such as South Korea. In the future countries likely to grant a Blockchain-based patent include Taiwan, the United States of America, Japan, and China. A European patent application looks to have little chance to success, the requirements as provided by the case law should be taken into strong consideration when applying for a patent in Europe. Managers should adjust their intellectual capital strategy to this consideration when trying to patent Blockchain technology in Europe.

The part of the technology to be patented is rooted in an assessment of patent-eligibility according the relevant national law. However, a single choice for either the distributed ledger or the technical effect seems not to be possible, based on the patent analysis and subsequent case law analysis. The patent analysis of granted patents shows that all systems disclose parts of both the distributed ledger and the associated technical effect. Thus, there is no such binary distinction between the two as presupposed in the sub-question. Rather, as in line with the discussed case law, it seems the patents must refer to the required features of both the distributed ledger as the technical effect of the application of said distributed ledger and that there is no preference as to what the invention aims to protect with respect to either layer of the Blockchain technology. Further, in the United States and European case law, it becomes apparent that the features to be disclosed should confer the technical effect, and in the case of the United States also the result of or on a physical entity, in such a way that this technical effect is not reliant on the fact that the invention operates on a computer program.

Finally, the claim formulation as divided in its three components can be concluded on. The preamble of a claim conferring an invention regarding Blockchain technology should have one method claim, followed by a claim on a physical feature, such as a 'system', a 'computer storage medium' or a 'device'. This is substantiated by the patent analysis, the case law analysis and the guidelines for patenting claim drafting for computer-implemented inventions. Furthermore, the body of the claim should refer to the features of the invention that encompass the requirements for patentability without consideration of the implementation of this invention in a computer program as the invention. If this is not done, in the U.S. the subject-matter will be considered to be an 'abstract idea' implemented in a computer program, which is not patent-eligible. In Europe, the features will not be considered in the assessment of inventive step as they are non-technical features, which is substantiated by the Guidelines for claim construction of computer-implemented inventions. Furthermore, especially with respect to the United States, the patents should be drafted so that the claims require only a single actor to perform all necessary steps to execute the invention. If not possible, the claims must be directed at controllable groups with the meaning of *Medgraph* in the decision of the Federal Court of Appeal.

7.1.6 Recommendations for Professionals

This section provides recommendations based on the research for the development of intellectual property law from a regulatory perspective and from the perspective of professionals in the field of intellectual property. In section 1.5, the problem statement was explained to have high-level implications as well. The generic gap between emerging high technology and intellectual property law is not only apparent in Blockchain technology but with many upcoming technologies, and this has been the case throughout history. This research provides a handle on how to deal with this situation from the perspective of the appropriation of patent protection for a specific technology. However, lessons can be derived on how to deal with the generic gap between emerging high tech and intellectual property law, both from the perspective of appropriation and from a regulatory perspective.

7.1.6.1 Regulatory Bodies and Intellectual Property Law

As was suggested in section 6.1.1, patent offices are generally more likely to become adoptive of emerging high technology, at least when drawing the comparison with (the once emerging and disruptive) field of computer software. However, the problem of the aforementioned generic gap manifests itself just as intellectual property has not adapted to the new technology yet. From a regulatory perspective, with reference to intellectual property law, the solution for the ill-equipped rigid law to deal with emerging high technologies lies in adopting a degree of flexibility. Naturally, the inclusion of flexibility in changing the law is extremely complex. From the perspective of the law, it would require making organizational changes in the development of the law, as well as changes in the collaboration between governments and large institutions. Of course, this is neigh impossible, it would require organizational change to a level that is simply not feasible. That being said, to induce a degree of flexibility in the law, a feedback process that is more direct could be implemented, to at least make legislators aware of all difficulties of the connection between intellectual property law and emerging high technology.

Patent offices in the world however, both regional and national, have the possibility to adopt some changes that might help in closing the gap between emerging high technology and intellectual property law. As mentioned, the flexibility of institutions to develop a response to feedback on a new technology is vital for the development of an efficient system for appropriating patents in a new field of technology. The patent prosecution procedure is extremely lengthy, for which the patent offices can hardly be blamed, the number of patents that are being filed at these offices is extremely large. To induce a degree of flexibility in patent offices a solution could be to make the costs of patents dependent on the revenue of the proprietor, so as to limit the level of intellectual property appropriation for the reason that it 'might come in handy' if a competitor aims to market a product. This would limit the number of patents filed at patent offices without blocking the entrance for proprietors with limited funds. Under those conditions, the price of patent appropriation can be higher without hampering innovation. Also, the patent offices could impose a fine on a patent rejection, this could induce higher efficiency for patent attorneys. After all, there is zero net benefit of a rejected patent when looking at the economy as a whole.

7.1.6.2 Professionals and Intellectual Property Law

In the appropriation of patents, both patent attorneys and the proprietors of the invention must be aware of the relevant limitations in both case law developments and technical developments so as to prepare for the difficulties that might arise from the attempt to patent a radically new technology for which intellectual property law is not adapted. Since these situations have more regard to the specific problem statement as discussed in this research, rather than the generic gap between emerging high technology and intellectual property law, this research could be used as an example to determine ways to investigate the patent-eligibility of the to be claimed invention.

7.1.7 Additional Considerations

A number of further considerations can be drawn from the research as these are not discussed in the above research questions but pose interesting topics. These points do not necessarily contribute to the research as such, but could provide valuable additions to the lessons as described above.

7.1.7.1 Relevance of Blockchain Dimensions

During the explanation of Blockchain technology in the literature review (see section 2.2.2.2), two dimensions have been identified in which the consensus mechanisms of the Blockchain technology could be identified along the axes of level of permission in the system and the accessibility (private or public) of the system. These dimensions were thought to have an influence on the strategy with which the inventions need to be patented. However, as it turns out, the type of consensus mechanisms has absolutely nothing to do with the optimal strategy to appropriate patent protection for said invention. The reason for this finding is founded in the requirement for a patent attorney to keep the scope of the alleged invention as broad as possible so as to attain an optimal degree protection. To do this, the patent attorney does not disclose the type of consensus mechanism unless absolutely necessary to execute the invention. As the disclosure of a specific consensus mechanisms limits the scope of protection in a patent severely, this is generally avoided. However, the need for the implementation of a Blockchain based system might be attributable to these dimensions. The level of permission is a measure for the centralization of the consensus mechanism and as such a level of the trust that is needed in the validation nodes to ensure operability of the system. Seeing as the main benefit of Blockchain technology is the fact that trust is no longer needed in peer-to-peer transactions, the implementation of a system wherein the validating nodes are fully permissioned results in a benefit-less system.

This brings us to a second point of consideration when assessing the value of Blockchain inventions, the applicability of the system is undeniable, but the value of that application is to be researched. While not the subject of this research, in fact quite the opposite, the question whether Blockchain is as marvellous as the hype would suggest is a question that still needs to be answered. A subjective determination of the value of Blockchain technology in a great manner of industries would likely result in a less optimistic view than what Blockchain enthusiasts would have you believe. This goes hand-in-hand with the consideration of the adoption rate in section 1.2.1, once it becomes accepted that the system merely provides a novel manner of performing transactions and in fact does not result in large amounts of rainbows and unicorns, the rate of patent applications might decline. However, the degree with which network technology is spreading, be it through telecommunications, Blockchain technology, cloud computing, cloud storage, Internet of Things, etc., the issues surrounding this research remain.

7.1.7.2 Effect of Intellectual Property Law on Innovation

As briefly touched upon in earlier chapter 2, the validity of the intellectual property system as an accelerator for innovation is questioned throughout literature. Especially when technologies are volatile and intellectual property law is relatively rigid, the appropriation of protection of intellectual property of those technologies is said to have a negative result on the development of technologies. As mentioned earlier, a solution for this problem is to close the generic gap between emerging high technology and intellectual property law. However, another consideration could be made, namely changing the valorising method of intellectual property rights from licensing to another method. If there was no basis of infringement in case of unbeneficial use of a patented technology, the barrier of intellectual property for the development of new technologies would be taken away. If a system of mandatory licensing with prices dependent on the benefit of the use of the invention were to be adopted, the 'infringing' party would only have to pay if she is successful in commercializing the application of that invention. This would create a situation where the use of novel technologies is actively promoted under the condition that these payments (as part of the benefit of the use of the invention) are high enough to stimulate patenting activity and low enough to induce the use of the inventions.

7.1.7.3 Effect of Open Source

As explained, the use of Open Source software is not relevant as the use of copyright as an intellectual property right has been excluded. Considering patents, the technical effect of an application is not achieved by writing code and therefore not part of the invention. Considering the layer of the distributed ledger or consensus mechanism for performing the transactions in the network, if an existing system is used that is produced in an Open Source environment, the technology is not an invention. Should a part of the system constitute an invention, and should there be Open Source code in the system, it is imperative that the claimed subject-matter does not include any features that have been produce by the inclusion of Open Source software.

While the effect of Open Source on the patent-eligibility is limited, given that no such code should be used in patented subject-matter, the context of the environment in which such code is written as opposed to the field of intellectual property law, which it strongly opposed, is very interesting. While again not a subject of this research, a very interesting topic of research could be to develop a system to identify when technologies are valorised and are transformed from a collaborative environment to a protected environment by large companies as can clearly be seen in the case of Blockchain technology. The tension between the Open Source community and the profit-driven companies that utilize the technology is a very interesting topic of research.

7.2 Discussion

This research aimed to address the generic gap between emerging high technology and intellectual property law. In doing so, the subject of Blockchain technology applications was chosen as an example of emerging high technology so as to solve how intellectual property law can be used to protect the intellectual property of Blockchain technology applications (see figure 5). In this section, improvements and recommendations for future research will be discussed. First, the connection with the high-level problem statement will be discussed, after which recommendations for future research will be provided, as well as certain considerations with respect to this specific research.

7.2.1 High-Level Problem Statement

Considering the high-level problem of the connection between emerging high technology and intellectual property law, this research aimed to provide a handle to deal with problematic connection between the highly flexible nature of emerging high tech and the highly rigid nature of intellectual property law. The methodology followed in this research might do so. It has identified a system for determining the best way to acquire patent protection for a new technology. To determine whether this is a viable solution for the high-level problem statement, the method must be tested in other fields of technology. The characteristics of said technology must then form the foundation of the validation of the decision-making framework. The theoretical decision-making framework is likely to be applicable to any other emerging high technology. However, it should be noted that this research does not solve the high-level problem as indicated in the first chapter of this research. Of course, the research points towards the existence of the identified problem first, and towards a solution second but that does not entail that the solution in this research will necessarily be applicable to other technologies wherein the fit of the technology with the law aimed at protecting its intellectual property is limited. The hypothesis that the generic drivers for the gap between intellectual property law and emerging high technology are the maturity of the technology and the demand for valorisation should be investigated to a further extend before any conclusions can be drawn with respect to the applicability of this research to the high-level problem statement.

7.2.2 Recommendations for Future Research

This researched aimed to provide insights into the generic gap between emerging high technology and intellectual property law, as indicated above. Because the field of research is very novel, further research would be advisable, especially in other fields of technology. To generalize this research so that it provides a handle on closing the generic gap between emerging high technology and intellectual property law, other technologies should prove to have similar characteristics on its connection with the law. If this is indeed the case, the application of this research on emerging high technology can be very valuable in the future. Considerations for future research can be categorized on two axes, the breadth of the technology and the breadth of jurisdictional application. Put simply, the results must be applicable over a vast range of technologies and all jurisdictions.

For the research to be applicable to all emerging high technology, and not only the technology that applies computer-implemented inventions, the research must be directed at a wide range of emerging technologies. The indicators for this generic gap as indicated in this research are applicable specifically to Blockchain technology applications. To generalize the research, one must identify the indicators of a problematic match between emerging high technology and intellectual property law over a wider range of technologies. The same can be said of the jurisdictions in the research. In this research, the application of the technology and language barriers limited the jurisdictional scope. Other technologies and other researchers might allow for a wider application of the research in various jurisdictions.

Once both the technological and jurisdictional breadth has been accomplished, the research can be generalized so as to ultimately close the gap between emerging high technology and intellectual property law.

7.2.3 Regulatory Voids

As the technology to which this research aims to bring some degree of structure is still developing, an important note to the contribution of this research is the existence of current states of regulatory voids. The fact that the technology is fundamentally in its infancy leads to believe that regulatory changes are at hand, the earlier mention of an ISO standard being one of them. Historically, the existence of regulatory voids leads to a level of self-regulation (Short, 2013), which can now also be seen in the Blockchain technology development community. Whether self-regulation in such a regulatory void will result in productive allocation of time and money is another question entirely but generally, any type of regulatory interference with regulatory voids, be it self-regulated or not, results in extensive changes of the technical field.

The result of these regulatory voids and their likelihood of being regulated by some sort of government entity, is time-dependency of the validity of this research as a solution to the specific problem statement. Depending on what will happen over the coming years, the results of what will be discovered is subject to change. Readers should note that the case as it has been presented in this document is likely to change over the years. This has been substantiated by literature, where the dynamic nature of habits, philosophies and tools and the resulting differences between patent offices over the world is provided as a reason for the volatility of filing and granting procedures of intellectual property rights (Pilch & Shalloe, 2005). Another contributing factor to the changes in the intellectual property law environment and globalization in the field can be attributed to short-sightedness of shareholders which leads inventors to cut costs and transfer production facilities across the world over time. The demand to do so freely leads many inventors to adopt patent protection in many countries, and by doing so to a higher demand for unity in the protection of intellectual property rights.

That being said, the research should provide a handle on dealing with changing regulations in the future, especially with respect to the connection between the law and the technology. The time-dependency of the research as presented on the specific case will not transcribe fully to the high-level implications of the research and the effects on legislators and inventors. As such, the research transcends the time-dependency due to regulatory voids by application to the high-level problem between emerging high technology and intellectual property law.

7.2.4 Jurisdictional Research

Due to limitations in language, not all jurisdictions of this research have been discussed equally. The translation mechanisms to convert various Asian languages to English were not sufficient to draw valid conclusions from either the patent analysis or the case law discussion. In future research either a consideration of language should be made on beforehand, or co-authors should be chosen strategically such that these limitations can be prevented. The conclusions from this research will mainly be relevant to the appropriation of Blockchain technology patents in Europe and the United States. While this might be an excellent achievement, it was shown that China and Korea are important jurisdictions in the field of Blockchain patents and as such should not be neglected.

Furthermore, the inclusion of multiple jurisdictions in the development of a decision-making framework, especially with respect to the aforementioned high-level problem statement, is imperative. The breadth of the research, even more so when regarding the global nature of many network-based technologies in the current state of technological development, should not be limited to jurisdictions. Therefore, both with the inclusion of the high-level problem statement and in further research regarding specific technologies, the jurisdictional limitations should be circumvented as best as possible.

7.2.5 Legal Asset Allocation

In addition to the above, a consideration with respect to Blockchain and other transactional network technologies, such as Internet of Things and cloud computing, is the legal possibility of asset appropriation through data. As briefly discussed in section 2.1.3.1, the ownership of data is a complex issue, wherein the legitimacy of legal asset allocation by data on a distributed ledger is unknown. Since the allocation of assets to a person or entity should be decided by national law, a distributed system such as Blockchain, might not be eligible for allocating this property from a legal perspective. The system is used for property allocation through various embodiments, but it is not clear whether this is legally possible. As ownership of assets represented by data is increasingly important in almost every industry, a consideration must be made to determine the admissibility of electronically produced ledgers as evidence of property. Specifically, when two systems are not in congruence with one another, what tests will determine the appropriation of assets. The law must specify the requirements for property allocation with data that is produced electronically and how to deal with jurisdictional issues regarding that appropriation. Future research should take into account the problems as provided by Guo on whether electronically produced ledgers are admissible in court as evidence (Guo, 2017), and how the correct jurisdictions for these considerations are determined.

7.2.6 Enforceability of smart contracts

In the research up until this point, smart contracts have been considered an integral part of the transactional system that comprises the distributed ledger, the smart contracts, and the technical effect of the implementation of such a technology. Another consideration can be made regarding the combination between intellectual property law and Blockchain technology, namely that off the enforceability in litigation proceedings. Two issues play a role in the enforceability of smart contracts in a Blockchain networks. First, the lack of a central authority to which disputes over smart contracts can be communicated and second, the lack of jurisdictional enforcement of the smart contract in case of such a dispute. Many of the current applications have smart contracts to which information of the network is provided, which is subsequently processed, and a decision is made. In the future however, it might be conceivable that a smart contract is not quite that binary in its execution and nodes could ‘argue’ over a certain level of execution of the smart contract. In such a case, the enforcement of the smart contract is a jurisdictional question, even under the assumption that the information from a system is admissible in court, the validity of a self-executing contract as a legally binding agreement is questionable. Although this has nothing to do with intellectual property right, and as such has not been discussed in the above chapters, this point is relevant for infringement cases of Blockchain patents. After all, jurisdictional infringement is a problematic issue for the litigation proceedings in Blockchain technology patents as well. Also, the admissibility of Blockchain-produced data in court is relevant to the above research and could be implemented in future reference (Guo, 2017).

7.2.7 Relevance for Management of Technology

As known to the reader, this research has been written in partial fulfilment of the Master of Science-program Management of Technology. This section will briefly discuss the connection between this thesis and various courses as provided in this M.Sc. program. First of all, the main issue addressed in this research, as previously mentioned is the connection between the law and emerging technologies. This is a historically problematic concept that has been touched upon in the course Technology Dynamics (MOT1412). During this course, the drivers and barriers in the process of innovation are discussed. This includes the problematic connection between standardized institutions and fundamentally disruptive technology. The course also highlighted some aspects regarding responsible innovation, and the social construction of technology. The relevance in this research with respect to these topics is the connection between the existence of intellectual property law and the level of technological development. As explained, this research refutes the negative connection between intellectual property law and emerging technology on the basis of the fundamental inability of intellectual property law but rather on its limited possibility to handle the characteristics of emerging technology. The solution as a result of this reasoning is not to abolish

intellectual property law but to find a way to create a level of congruence between the law and emerging technology so as to capture the benefits of intellectual property law in emerging technology without limiting the development of said technology.

Another course that can be identified in this research is Technology Strategy and Entrepreneurship (MOT1435), where the influence of emerging technology on standards was a core concept. As previously mentioned, the presence of patents, in many cases can lead to the development of standards with subsequent compulsory licenses. Corporate strategy in controlling the standardization of a technology involves intellectual property to a considerable extent. Naturally, the development of technology with high rates of adoption, for which a strong intellectual property position is sought, leads this research to be quite relevant. The course describes the high importance of the position a firm adopts in a fundamentally uncertain external environment, to which the structure of an intellectual property portfolio aids to a large extent, after all, the development of a standardized technology is an excellent position to be in, only if a monopoly can be enforced.

A third course that has a strong connection with the subject of this thesis is Leadership and Technology Management (MOT1531). In this course, fundamental methods for knowledge management are introduced, which focusses itself on the transfer of said knowledge between actors in a high-tech firm. With reference to this knowledge transfer, and more specifically the protection of this knowledge during such a knowledge transfer in a high-tech company, the use of intellectual property is highly relevant. Some key considerations in the development of a management approach can fundamentally be based on the existence of an intellectual property portfolio to contain said knowledge.

Finally, Emerging and Breakthrough Technologies (MOT2421) is a course in which the development of highly disruptive technologies is extensively discussed. The relevance between this course and the research is the volatile nature of technologies at the beginning of their lifecycles. The proposition of this research aims at providing a solution, to a certain extent, to the problems highlighted in this course. The volatile nature of technology is difficult to control, and efforts should not be made to do so, as this might hamper the level with which technology develops. On the other hand, creating a proposition with which the sluggish institutions that deal with these technologies can display an increased level of flexibility, as is being attempted in this research, could increase the connection between these institutions and emerging technology.

In addition to the above, certain points of this thesis touch with specific parts of courses, without displaying a connection as evident as with the above examples. However, it should be noted that in the current level of technological advancement, in a world that is increasingly characterized by a high rate of technological development, the protection of ideas and the valorisation of R&D efforts is an extremely relevant managerial topic. The creation of these intellectual assets, now more than ever, with technology that is increasingly globally oriented, is thus a topic that constitutes strategic considerations on a high level. Considering the above, the relevance of intellectual property in the module of Management of Technology is apparent to the extent that an argument could be made to include educational measures in the program as a mandatory component.

"Bach is like an astronomer who, with the help of ciphers, finds the most wonderful stars. Beethoven embraced the universe with the power of his spirit. I do not climb so high. A long time ago I decided that my universe will be the soul and heart of man."

– Frederic Chopin –

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Appendix A – Abbreviations

ARIPO	African Regional Intellectual Property Organization
Art.	Article
BFT	Byzantine Fault Tolerance
CAFC	US Court of Appeal for the Federal Circuit
CIPA	Chartered Institute of Patent Attorneys
CPU	Computer Processing Unit
DAG	Directed Acyclic Graph
DLT	Distributed Ledger Technology
DC	Dependent Claim
DPMA	German Patent Office
DPO	Dutch Patent Office
DPoS	Delegated Proof of Stake
EAPO	Eurasian Patent Organization
EPC	European Patent Convention
EPI	European Patent Institute
EPO	European Patent Office
EPOrg	European Patent Organization
FBA	Federated Byzantine Agreement
FRAND	Fair, Reasonable and Non-Discriminatory
GATT	General Agreement on Tariffs and Trade
GNU	GNU's Not Unix
GNU GPL	GNU General Public License
GUI	Graphical User Interface
IC	Independent Claim
ICO	Initial Coin Offering
IoT	Internet of Things
IP	Intellectual Property
IPEA	International Preliminary Examining Authority
IPER	International Preliminary Examination Report
IPO	Intellectual Property Office (of the United Kingdom)
IPR	Intellectual Property Right
ISA	International Searching Authority
ISO	International Standard Organization

JPO	Japan Patent Office
KIPO	Korean Intellectual Property Office
MIT	Massachusetts Institute of Technology
M.Sc.	Master of Science
NSA	National Security Agency
OJ	Official Journal of the European Patent Office
OSI	Open Source Initiative
PBFT	Practical Byzantine Fault Tolerance
PCT	Patent Cooperation Treaty
PoS	Proof of Stake
PoW	Proof of Work
PRC	People's Republic of China
R.	Rule
Rev.	Revised
ROW	RijksOctrooiWet (Dutch Patent Act)
SHA	Secure Hash Algorithm
SIPO	State Intellectual Property Office of the People's Republic of China
SISA	Supplementary International Searching Authority
TM	Trade Mark
TP	Technical Part
TRIPS	Agreement on Trade-Related Aspects of Intellectual Property Rights
UPC	Unified Patent Court
USPTO	United States Patent and Trademark Office
WCT	WIPO Copyright Treaty
WIPO	World Intellectual Property Organization
WTO	World Trade Organization

Appendix B – List of Definitions

Apache 2.0 License

As with most Open Source licenses, the Apache 2.0 License has been developed to deter developers from keeping their code secret after using someone else's code. It has been developed by the Apache Software Foundation and has been operational under the 2.0-version since 2004 (Apache, 2004). It allows users to copy code for both commercial and private use, to distribute and to modify code. However, a user is also obligated to state any changes made in the code and include a copyright and the Apache 2.0 license (Wang, 2013). This means that anyone using licenced code has the obligation to allow other people to use your adaptation of the code. Thereby refuting all possibility to claims for patent applications.

Blockchain

A Blockchain is a growing list of records, called a ledger, using public-key cryptography to sign transactions, which is distributed among the participants, called nodes, in a network. Blocks are completed transactions which are added to this distributed ledger over time (Rosario, 2017). Note that in the definition as used in this research, the fundamental layer of the Blockchain technology comprises of a wider range of technological possibilities, so as to include all distributed ledger technologies. This means that the Blockchain definition as per above does not necessarily entail blocks.

Case Law

Case law refers to the law as established by the outcome of former cases, rather than legislative action. Essentially, case law is an overview of decisions by courts that provide other interpretations of the law (Lehman & Phelps, 2005). On the website of the World Intellectual Property Organization (WIPO), a large overview of case law is publicly available.

Claims

In the field of Intellectual Property law, specifically Patent Law, Claims are *"A series of numbered statements in a patent specification, usually following the description, that define the invention and establish the scope of the monopoly conferred by the patent."* (White, 2018).

Compulsory License

A compulsory license is a license of which the proprietor cannot refuse the use, in exchange for a license fee. These licenses are often attributed to a standard, where the use of a technology is mandatory. To limit the power of the proprietor of such a technology, the license is made compulsory, against fair, reasonable and non-discriminatory (FRAND) terms.

Copyright

A copyright is a legal monopoly that protects creative work, published or unpublished, of an author. The advantages of copyrights are that they are long-lasting (the life of the author in almost each case, often longer), they are free, and they are international (U.S. Copyright Office, 2017). Downsides of copyright protection are that it does not cover purely technical issues, it is not the strongest protection and often there is an evidence issue because copyright is often only brought forward at a litigation process, rather than having anything granted on beforehand.

Crowdsale

In contrast with crowdfunding, a crowdsale does not involve the purchase of a (future) tangible asset. In return for the funding provided by the crowd, tokens (see tokens) are issued. Tokens are essentially the coins of cryptocurrencies, either with or without a use liked to the token. For example, Edgeless is an online gambling platform for which tokens are used to place bets. These coins hold 'real life' value because they can be used to access a platform. The crowdsale is designed to raise capital for the Blockchain-based firm and has the possibility to do so in a very early stage.

Distributed ledger

The distributed ledger is essentially the foundation on which the concept of Blockchain technology is built. Blockchain technology, as mentioned earlier, requires some sort of record of transactions of which everyone has a copy. This record is the distributed ledger. The concept of the distributed ledger has existed throughout the history of mankind, earliest forms being written on clay. An overview of transactions has been a necessary tool since trading emerged and markets were created, in its most rudimentary form. Two main points for the distributed ledger are vital. First, it is a list of transactions. Second, at all times, every participant in the network should own an exact copy of it (Bauerle, 2017).

Double Spending Problem

The main reason for the existence of the Blockchain system, as proposed by Nakamoto was the aim to find a solution to the so-called double spending problem (Nakamoto, 2008). This is a situation, wherein a transaction is no longer verified by a trusted third party but happens between two peers, who cannot determine the validity of the transaction. With no such regulatory body (as the third party) to verify the transactions, a malicious transaction could be generated by simply copying the account on which an asset is deposited and sending that asset to multiple recipients. The reason we cannot spend money twice, is because a bank makes sure to track our account balance, when that controlling factor is gone, the possibilities for double spending quickly arise, and with that, according to Nakamoto, the demand for a peer-to-peer system that ensures trusted transactions without a third party.

Ethereum

According to the team that built the system, Ethereum is “a decentralized platform that runs smart contracts, applications that run exactly as programmed without any possibility of downtime, censorship, fraud or third-party interference” (Buterin, 2017). This is a marketing definition, it holds for Ethereum, but also for all other Blockchains. The definition by Crunchbase adds that Ethereum is a platform and programming language that supports developers in creating their own applications of the foundations of the Ethereum Blockchain (Crunchbase, 2017). This is important in this research as the availability of a Blockchain on which smart contracts can be run, skews the ease of production towards just developing the smart contracts and not build the entire Blockchain yourself.

FRAND-Terms

Fair, Reasonable and Non-Discriminatory (FRAND) Terms is terminology used by standard-organizations to denote their request from the proprietor of a technology upon consideration for the standard. To be eligible for inclusion in a standard, which can be very lucrative for the proprietor, he is requested to allow his intellectual property to become a compulsory licensed intellectual property right that is subjected to FRAND-terms, thereby giving up the exclusivity of the right to license (or to exclude certain entities from licenses).

GATT

The General Agreement on Tariffs and Trade was originally discussed by the United Nations Conference on Trade and Employment and was in effect until 1994 with the creation of the World Trade Organization. The WTO still holds the agreements of GATT, albeit with amendments in 1994. In GATT, the TRIPS agreement (see TRIPS definition) holds the requirements for member states with respect of intellectual property law.

GNU GPL License

The GNU GPL License is an Open Source license, created by Richard Stallman (see *Open Source*) as part of the GNU (GNU’s Not Unix) project, which is closely linked to the Open Source Foundation. The GNU GPL (General Public License) Allows users to use the code commercially, modify and distribute it, place a warranty on it and use its patent claims. In contrast with the Apache 2.0 and MIT licenses, users are not allowed to sublicense the code. Users are obliged to include the original work, state changes, disclose the sources, and include the license and copyright (Stallman, Licenses, 2016).

Hash Function

The hash function is a concept that is used in cryptography to transpose any data to a certain set of digits. This set of digits is called the hash. It always has the same length, which makes looking for similarities in the data produced by a hash function very easy. Identical data will always produce identical hashes. The complexity of the hash function increases, it becomes difficult to determine what the original data was. This allows someone seeing the data only to verify original data by comparing it with another hash, produced by the same data. The hash-function, with high complexity, becomes a one-way gate to a set-number digit string. Knowing what sort of hash function has been used, a recipient of a transaction can verify the identity of a sender in a cryptocurrency environment.

HOYNG ROKH MONEGIER

HOYNG ROKH MONEGIER is an intellectual property law firm, specialized in European intellectual property law. It was created in 2015 when renowned firms Hoyng Monegier and Reimann Osterrieth Köhler Haft (ROKH) merged to form HOYNG ROKH MONEGIER. With offices in Amsterdam, Brussels, Düsseldorf, Madrid, Mannheim, Munich and Paris, the firm caters to many prominent clients in the field of intellectual property law, including patents and trade secrets, trademarks, copyrights and designs rights, as well as in related fields, such as pharmaceutical regulatory law, unfair competition, media and advertising law and all other IP related contracts. (Hoyng Rokh Monegier, 2017). It has been crowned European Patent Firm of the Year 2016 by JUVE, an industry analyst considered to be one of the important parties in law recognition (JUVE, 2017). In 2017, the firm has been awarded the title of firm of the year in both the Netherlands and France in the field of IP law by Managing Intellectual Property (Managing IP, 2017).

Hydrachain

The Hydrachain is a Permissioned Distributed Ledger based on Ethereum, it aims to contribute to development of private chain or consortium chain utilities. Its main advantages over development through Ethereum are the high-level coding infrastructure that provides faster execution of native contracts and faster development. Also, the validation mechanism of the system is different from that of Ethereum, it uses accountable validators for the process, rather than proof-of-work, as traditional Blockchains do (Hydrachain, 2016). The Hydrachain project provides its tooling under the MIT license.

Hyperledger

The Linux Foundation started the Hyperledger platform in collaboration with leading parties from several industries. Its goal is to accelerate Blockchain technology innovation based on an Open Source structure, through collaborative efforts with the leading partners. The aim of the Hyperledger project is to integrate cross-industry knowledge who share their abilities, connections and capacity with one another (Hyperledger, About Hyperledger, 2017).

Initial Coin Offering (ICO)

An Initial Coin Offering, or ICO, is a way of funding a new cryptocurrency. Parallels are often drawn between initial public offerings and ICOs, but they are not quite the same. ICOs are unregulated and their value is often based on speculation because the assets do not exist yet. Because of this, regulation is starting to limit possibilities in which ICOs can be brought onto the market, although no one country has the same approach (Medina, 2017). An ICO can be described as a decentralized crowdfunding project, a way to perform an unregulated public offering without assets. So far, ICOs have raised over three billion dollars and it has happened that an ICO has raised thirty-five million dollars in less than a minute (Verhage, Russo, & Katz, 2017).

Intellectual Property

Intellectual property is defined as a creation of the mind used in commerce, by WIPO. This definition is rather broad but the addition of ‘used in commerce’ is a valuable addition as it allows to discard any thing that is merely an idea or a concept. It makes the concept of intellectual property much more tangible that it would otherwise have been.

Joint Infringement

Joint infringement, or divided infringement, is a situation wherein infringement is not attributed to a single actor but rather to multiple actors, who perform the infringing act by means of combination of activities. Following U.S. case law (see section 6.2.1), Akamai v. Limelight provided the latest decision on the subject. Here, the court stated that joint infringement was substantiated under the circumstances that actors form a joint enterprise, or where an infringing party leads partial infringers to infringing acts. As such, joint infringement can be attributed to single actors, while these might not perform the infringing acts themselves.

Monax

Monax is a platform for that facilitates the creation of applications based on Blockchain, through providing developers with chains, packages, keys, files, and services (Monax, 2017). These all fall under the Apache 2.0 License.

MIT License

The MIT License is similar to the Apache 2.0 License, it also provides free use, both commercial and private, of the code. It also allows to modify and distribute the code. And it also comes with an obligation to include copyright and to include the license. The MIT License does not oblige its user to state chance and include a notice. Also, the use of a trademark is possible and there is no possibility to use patent claims (Open Source Initiative, The MIT License, 2017).

Multichain

Multichain is a Blockchain development platform that facilitates the creation of applications that require Blockchain implementation. It is based on private Blockchains and holds no license agreement, only trademark protection.

Node

A node is defined as a point in a network. What this node does exactly is generally not specified other than the ability to create, receive, store or send data over a network (Rouse, 2016). However, in this research, we use the concept of a node as applied in a Blockchain network, where it is defined as a distributional or a communicative endpoint meaning that nodes transfer information until the collective set of nodes acquired enough information to draw a conclusion, in the case of Blockchain to verify transactional data. Each user in a Blockchain network functions as a node.

Open source

The initial push for Open Source licensing came from Richard Stallman, then software programmer at the Massachusetts Institute of Technology. With changing legislation on the subject of copyright, and increasing value to be retrieved from code, secrecy and protection around the development of software started to increase. Richard Stallman is the main advocate of the 'copyleft' movement, which ultimately led to the General Public License, the most widely used Open Source license, by the GNU Project. An important note on this license (and most other licenses for that matter), is that one can freely use the code as long as the new content is then also administered to the Open Source movement. In practice, this means that any use of Open Source code (even if it is only a small part), is immediately a publication and by that logic a full barrier for a patent application.

Open Source Initiative (OSI)

The Open Source Initiative is a non-profit organization tasked with determining the viability of a licence to constitute 'Open Source'. The organization was founded by Bruce Perens and Eric S. Raymond as a result to the choice by Netscape to publish the source code of their web-browser. The Open Source Initiative has approved a considerable number of Open Source licenses (Open Source Initiative, Licenses by Name, 2018).

Openchain

Openchain is a distributed ledger technology for asset management. Use cases, as mentioned by Openchain, are securities in stocks and bonds, commodities like gold and oil, currencies, ownership of land, music or software, gift cards or loyalty points. Because the system uses Portioned Consensus (only one authority validates transactions), the speed of the system is relatively high. It advocates Open Source and mentions no license on the website but through GitHub it seems that the system is licenced through an Apache 2.0 License.

Patent

Initially meant to stimulate innovation, a patent is essentially a trade-off between an inventor and the rest of the world. In exchange for the privilege of the exclusive right to use the invention, the inventor must tell the world how his invention works, so that knowledge is shared more quickly. Whether this ideological statement holds in today's society is to be discussed in another paper. A patent is the exclusive right to perform activities, as described in the claims, and the exclusion of third parties of that use, for a specific amount of time, granted by the state, for use in that state (Cook, 2015). Hence, a patent is limited by the scope of protection of the claims, territory, time, and the list of exclusive acts in national law and with extension, the indirect acts.

Property

As property is a term that will be used a lot in this thesis, it should be defined as close as possible to the working principles of institutions that will be dealt in the research. Lacking definitions in the databases of both the European Patent Office and the US Patent and Trademark Office, this research will use the definition as proposed by Georgy Ishmaev in his paper on the possibility of Blockchain as an institution of property. He combines the views of James Penner in his 1997 book, *The Idea of Property in Law* and that of Georg Hegel in his book Elements of the Philosophy of Right. Ishmaev derives his definition of property from the concepts of exclusivity, separability, and recognition, by which he implies that the right to property includes the right to exclude others to use the property, the transferal of the right and the recognition by society of that right.

Public-Key Cryptography

The fundamental system that the Blockchain originally was built upon is public-key cryptography. It relies on the production of a key-pair, consisting of both a Private key and a Public key. The key-pairs facilitate two important functions in cryptography, authorization and encryption. In authorization, the public key of someone may verify that the message was sent by the holder of the private key of that same key-pair. In other words, if you receive a message from person A, and you want to be sure that person A actually sent the message, you can use their public key to verify that it was sent using the private key that only person A knowns. In encryption, the public key of a recipient can be used to encrypt the data in such a way that only the private key can decrypt it. This means that the data will only be readable by the holder of the specific private key, and not someone else.

Smart contracts

Smart contracts are defined as "self-executing scripts that reside on the Blockchain that allow for the automation of multi-step processes" (Kosba, Miller, Shi, Wen, & Papamanthou, 2016). The original concept was introduced by Nick Szabo in 1996 and defined as "a set of promises, specified in digital form, including protocols within which the parties perform on these promises" (Szabo, 1996).

Token

In cryptocurrency, a token represents one entity. One Bitcoin, for instance, is a token. These tokens can be used to access certain functionalities that the company that issued them provides but that is not a necessity.

TRIPS

The agreement on trade-related aspects of intellectual property rights (TRIPS) is an agreement between the member states of the World Trade Organization. In TRIPS, the minimum standards of intellectual property law for countries that want to take part in the World Trade Organization are stipulated. This agreement is a part of the General Agreement on Tariffs and Trade (GATT), to which all member-nations of the WTO are subjected.

World Intellectual Property Organization (WIPO)

Founded by the United Nations, the World Intellectual Property Organization is one of the seventeen specialized agencies. It concerns itself with international treaties, with its headquarters in Geneva, Switzerland. The World Intellectual Property Organization has 191 member-states and administers 26 treaties with worldwide rules about various aspect of intellectual property law.

Appendix C – Selected Patent Law Articles

European Patent Convention

Article 52 – Patentable inventions

1. European patents shall be granted for any inventions, in all fields of technology, provided that they are new, involve an inventive step and are susceptible of industrial application.
2. The following in particular shall not be regarded as inventions within the meaning of paragraph 1:
    a. discoveries, scientific theories and mathematical methods;
    b. aesthetic creations;
    c. schemes, rules and methods for performing mental acts, playing games or doing business, and programs for computers;
    d. presentations of information
3. Paragraph 2 shall exclude the patentability of the subject-matter or activities referred to therein only to the extent to which a European patent application or European patent relates to such subject-matter or activities as such.

Article 53 – Exceptions to patentability

European patents shall not be granted in respect of:

a. inventions the commercial exploitation of which would be contrary to "ordre public" or morality; such exploitation shall not be deemed to be so contrary merely because it is prohibited by law or regulation in some or all of the Contracting States;
b. plant or animal varieties or essentially biological processes for the production of plants or animals; this provision shall not apply to microbiological processes or the products thereof;
c. methods for treatment of the human or animal body by surgery or therapy and diagnostic methods practised on the human or animal body; this provision shall not apply to products, in particular substances or compositions, for use in any of these methods.

Article 54 – Novelty

1. An invention shall be considered to be new if it does not form part of the state of the art.
2. The state of the art shall be held to comprise everything made available to the public by means of a written or oral description, by use, or in any other way, before the date of filing of the European patent application.
3. Additionally, the content of European patent applications as filed, the dates of filing of which are prior to the date referred to in paragraph 2 and which were published on or after that date, shall be considered as comprised in the state of the art.
4. Paragraphs 2 and 3 shall not exclude the patentability of any substance or composition, comprised in the state of the art, for use in a method referred to in Article 53(c), provided that its use for any such method is not comprised in the state of the art.
5. Paragraphs 2 and 3 shall also not exclude the patentability of any substance or composition referred to in paragraph 4 for any specific use in a method referred to in Article 53(c), provided that such use is not comprised in the state of the art.

Article 56 – Inventive step

An invention shall be considered as involving an inventive step if, having regard to the state of the art, it is not obvious to a person skilled in the art. If the state of the art also includes documents within the meaning of Article 54, paragraph 3, these documents shall not be considered in deciding whether there has been an inventive step.

Article 57 – Industrial application

An invention shall be considered as susceptible of industrial application if it can be made or used in any kind of industry, including agriculture.

Article 60 – Right to a European patent

1. The right to a European patent shall belong to the inventor or his successor in title. If the inventor is an employee, the right to a European patent shall be determined in accordance with the law of the State in which the employee is mainly employed; if the State in which the employee is mainly employed cannot be determined, the law to be applied shall be that of the State in which the employer has the place of business to which the employee is attached.
2. If two or more persons have made an invention independently of each other, the right to a European patent therefor shall belong to the person whose European patent application has the earliest date of filing, provided that this first application has been published.
3. In proceedings before the European Patent Office, the applicant shall be deemed to be entitled to exercise the right to a European patent.

Article 63 – Term of the European Patent

1. The term of the European patent shall be 20 years from the date of filing of the application.
2. Nothing in the preceding paragraph shall limit the right of a Contracting State to extend the term of a European patent, or to grant corresponding protection which follows immediately on expiry of the term of the patent, under the same conditions as those applying to national patents:
    a. in order to take account of a state of war or similar emergency conditions affecting that State;
    b. if the subject-matter of the European patent is a product or a process for manufacturing a product or a use of a product which has to undergo an administrative authorisation procedure required by law before it can be put on the market in that State.
3. Paragraph 2 shall apply mutatis mutandis to European patents granted jointly for a group of Contracting States in accordance with Article 142.
4. A Contracting State which makes provision for extension of the term or corresponding protection under paragraph 2(b) may, in accordance with an agreement concluded with the Organisation, entrust to the European Patent Office tasks associated with implementation of the relevant provisions.

Article 64 – Rights conferred by a European patent

1. A European patent shall, subject to the provisions of paragraph 2, confer on its proprietor from the date on which the mention of its grant is published in the European Patent Bulletin, in each Contracting State in respect of which it is granted, the same rights as would be conferred by a national patent granted in that State.
2. If the subject-matter of the European patent is a process, the protection conferred by the patent shall extend to the products directly obtained by such process.
3. Any infringement of a European patent shall be dealt with by national law.

Article 66 – Equivalence of European filing with national filing

A European patent application which has been accorded a date of filing shall, in the designated Contracting States, be equivalent to a regular national filing, where appropriate with the priority claimed for the European patent application.

Article 69 – Extent of protection

1. The extent of the protection conferred by a European patent or a European patent application shall be determined by the claims. Nevertheless, the description and drawings shall be used to interpret the claims.
2. For the period up to grant of the European patent, the extent of the protection conferred by the European patent application shall be determined by the claims contained in the application as published. However, the European patent as granted or as amended in opposition, limitation or revocation proceedings shall determine retroactively the protection conferred by the application, in so far as such protection is not thereby extended.

Article 83 – Disclosure of the invention

The European patent application shall disclose the invention in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art

Article 84 – Claims

The claims shall define the matter for which protection is sought. They shall be clear and concise and be supported by the description.

Article 88 – Claiming Priority

1. An applicant desiring to take advantage of the priority of a previous application shall file a declaration of priority and any other document required, in accordance with the Implementing Regulations.
2. Multiple priorities may be claimed in respect of a European patent application, notwithstanding the fact that they originated in different countries. Where appropriate, multiple priorities may be claimed for any one claim. Where multiple priorities are claimed, time limits which run from the date of priority shall run from the earliest date of priority.
3. If one or more priorities are claimed in respect of a European patent application, the right of priority shall cover only those elements of the European patent application which are included in the application or applications whose priority is claimed.
4. If certain elements of the invention for which priority is claimed do not appear among the claims formulated in the previous application, priority may nonetheless be granted, provided that the documents of the previous application as a whole specifically disclose such elements.

Article 97 – Grant or refusal

1. If the Examining Division is of the opinion that the European patent application and the invention to which it relates meet the requirements of this Convention, it shall decide to grant a European patent, provided that the conditions laid down in the Implementing Regulations are fulfilled.
2. If the Examining Division is of the opinion that the European patent application or the invention to which it relates does not meet the requirements of this Convention, it shall refuse the application unless this Convention provides for a different legal consequence.
3. The decision to grant a European patent shall take effect on the date on which the mention of the grant is published in the European Patent Bulletin.

Article 99 – Opposition

1. Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid.
2. The opposition shall apply to the European patent in all the Contracting States in which that patent has effect.
3. Opponents shall be parties to the opposition proceedings as well as the proprietor of the patent.

4. Where a person provides evidence that in a Contracting State, following a final decision, he has been entered in the patent register of such State instead of the previous proprietor, such person shall, at his request, replace the previous proprietor in respect of such State. Notwithstanding Article 118, the previous proprietor and the person making the request shall not be regarded as joint proprietors unless both so request.

United States Code

Title 35, Section 101 – Inventions Patentable

Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

Title 35, Section 102 – Conditions for Patentability; novelty

(a) Novelty; Prior Art.—A person shall be entitled to a patent unless—
  (1) the claimed invention was patented, described in a printed publication, or in public use, on sale, or otherwise available to the public before the effective filing date of the claimed invention; or
  (2) the claimed invention was described in a patent issued under section 151, or in an application for patent published or deemed published under section 122(b), in which the patent or application, as the case may be, names another inventor and was effectively filed before the effective filing date of the claimed invention.

(b) Exceptions. —
  (1) Disclosures made 1 year or less before the effective filing date of the claimed invention. —A disclosure made 1 year or less before the effective filing date of a claimed invention shall not be prior art to the claimed invention under subsection (a)(1) if—
    (A) the disclosure was made by the inventor or joint inventor or by another who obtained the subject-matter disclosed directly or indirectly from the inventor or a joint inventor; or
    (B) the subject-matter disclosed had, before such disclosure, been publicly disclosed by the inventor or a joint inventor or another who obtained the subject-matter disclosed directly or indirectly from the inventor or a joint inventor.
  (2) Disclosures appearing in applications and patents. —A disclosure shall not be prior art to a claimed invention under subsection (a)(2) if—
    (A) the subject-matter disclosed was obtained directly or indirectly from the inventor or a joint inventor;
    (B) the subject-matter disclosed had, before such subject-matter was effectively filed under subsection (a)(2), been publicly disclosed by the inventor or a joint inventor or another who obtained the subject-matter disclosed directly or indirectly from the inventor or a joint inventor; or
    (C) the subject-matter disclosed and the claimed invention, not later than the effective filing date of the claimed invention, were owned by the same person or subject to an obligation of assignment to the same person.

(c) Common Ownership Under Joint Research Agreements. —Subject matter disclosed, and a claimed invention shall be deemed to have been owned by the same person or subject to an obligation of assignment to the same person in applying the provisions of subsection (b)(2)(C) if—
  (1) the subject-matter disclosed was developed and the claimed invention was made by, or on behalf of, 1 or more parties to a joint research agreement that was in effect on or before the effective filing date of the claimed invention;
  (2) the claimed invention was made as a result of activities undertaken within the scope of the joint research agreement; and
  (3) the application for patent for the claimed invention discloses or is amended to disclose the names of the parties to the joint research agreement.

(d) Patents and Published Applications Effective as Prior Art.—For purposes of determining whether a patent or application for patent is prior art to a claimed invention under subsection (a)(2), such patent or application shall be considered to have been effectively filed, with respect to any subject-matter described in the patent or application—

(1) if paragraph (2) does not apply, as of the actual filing date of the patent or the application for patent; or
(2) if the patent or application for patent is entitled to claim a right of priority under section 119, 365(a), 365(b), 386(a), or 386(b), or to claim the benefit of an earlier filing date under section 120, 121, 365(c), or 386(c), based upon 1 or more prior filed applications for patent, as of the filing date of the earliest such application that describes the subject-matter.

Title 35, Section 103 – Conditions for patentability; non-obvious subject-matter

A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

Patent Law of the People's Republic of China

Article 22

Inventions and utility models for which patent rights are to be granted shall be ones which are novel, creative and of practical use.

Novelty means that the invention or utility model concerned is not an existing technology; no patent application is filed by any unit or individual for any identical invention or utility model with the patent administration department under the State Council before the date of application for patent right, and no identical invention or utility model is recorded in the patent application documents or the patent documentations which are published or announced after the date of application.

Creativity means that, compared with the existing technologies, the invention possesses prominent substantive features and indicates remarkable advancements, and the utility model possesses substantive features and indicates advancements.

Practical use means that the said invention or utility model can be used for production or be utilized and may produce positive results.

For the purposes of this Law, existing technologies mean the technologies known to the public both domestically and abroad before the date of application.

Appendix D – Guidelines for Examination (EPO)

Part F, Chapter IV – The European Patent Application, Claims

3.1 - Categories

The EPC refers to different "categories" of claim ("products, process, apparatus or use"). For many inventions, claims in more than one category are needed for full protection. In fact, there are only two basic kinds of claim, viz. claims to a physical entity (product, apparatus) and claims to an activity (process, use). The first basic kind of claim ("product claim") includes a substance or compositions (e.g. chemical compound or a mixture of compounds) as well as any physical entity (e.g. object, article, apparatus, machine, or system of co-operating apparatus) which is produced by a person's technical skill. Examples are: "a steering mechanism incorporating an automatic feed-back circuit ..."; "a woven garment comprising ..."; "an insecticide consisting of X, Y, Z"; or "a communication system comprising a plurality of transmitting and receiving stations". The second basic kind of claim ("process claim") is applicable to all kinds of activities in which the use of some material product for effecting the process is implied; the activity may be exercised upon material products, upon energy, upon other processes (as in control processes) or upon living things (see, however, G-II, 4.2 and G-II, 5.4). (Rule 43(2))

If the subject-matter of a European patent is a process, the protection conferred by the patent extends to the products directly obtained by such a process. (Art. 64(2))

3.9 - Claims directed to computer-implemented inventions

The expression "computer-implemented inventions" (CII) covers claims which involve computers, computer networks or other programmable apparatus, whereby at least one feature is realised by means of a program.

Claims directed to CII should define all the features which assure the patentability of the process which the computer program is intended to carry out when it is run (see F-IV, 4.5.2, last sentence). An objection under Art. 84 may arise if the claims contain program listings. Short excerpts from programs may be accepted in the description (see F-II, 4.12).

In the following two sections, a distinction is made between two situations. The practice defined in F-IV, 3.9.1, is confined to inventions in which all the method steps can be carried out by generic data processing means. F-IV, 3.9.2, on the other hand, relates to inventions in which at least one method step requires the use of specific data processing means or other technical devices as essential features.

3.9.1 Cases where all method steps can be fully implemented by generic data processing means

A common type of CII relates to subject-matter where all the method steps can fully be carried out by computer program instructions running on means which, in the context of the invention, provide generic data processing functions. Such means can, for example, be embedded in a personal computer, smartphone, printer etc. In such inventions, although different claim structures are possible, the set of claims usually starts with a method claim. Further claims in other categories with subject-matter corresponding to that of the method may be included to obtain complete protection of the invention. If the invention concerns software which can be loaded into memory, transmitted over a network or distributed on a data carrier, a claim to a computer program [product] may also be present in addition to a computer-implemented method. The category of a computer program [product] claim is distinguished from that of a corresponding computer-implemented method (T 424/03 and G 3/08). The following non-exhaustive list comprises examples of acceptable claim formulations (T 410/96, T 1173/97 and T 2140/08) in such a set of claims:

(i) Method claim (claim 1)

– A computer-implemented method comprising steps A, B, ...

– A method carried out by a computer comprising steps A, B, ...

(ii) Apparatus/device/system claim (claim 2)

– A data processing apparatus/device/system comprising means for carrying out [the steps of] the method of claim 1.

– A data processing apparatus/device/system comprising means for carrying out step A, means for carrying out step B, ...

– A data processing apparatus/device/system comprising a processor adapted to/configured to perform [the steps of] the method of claim 1.

(iii) Computer program [product] claim (claim 3)

– A computer program [product] comprising instructions which, when the program is executed by a computer, cause the computer to carry out [the steps of] the method of claim 1.

– A computer program [product] comprising instructions which, when the program is executed by a computer, cause the computer to carry out steps A, B, ...

(iv) Computer-readable [storage] medium/data carrier claim (claim 4)

– A computer-readable [storage] medium comprising instructions which, when executed by a computer, cause the computer to carry out [the steps of] the method of claim 1.

– A computer-readable [storage] medium comprising instructions which, when executed by a computer, cause the computer to carry out steps A, B, ...

– A computer-readable data carrier having stored thereon the computer program [product] of claim 3.

– A data carrier signal carrying the computer program [product] of claim 3.

In formulation (ii) above, apparatus features of the means-plus-function type ("means for ...") are interpreted as means adapted to carry out the respective steps/functions, rather than merely means suitable for carrying them out (T 410/96). There is no particular preference of wording among "comprising means for", "adapted to", "configured to" or equivalents. In this way, novelty is conferred over an unprogrammed data processing apparatus or a data processing apparatus programmed to perform a different function.

An objection under Rule 43(2) should not be raised if the claim set comprises one claim from each of the above formulations (i)-(iv). In these cases, an invitation under Rule 62a(1) should therefore not be sent at the search stage since the requirements of Rule 43(2) are fulfilled.

However, an objection under Rule 43(2) may be raised if more than one claim is present from a heading (i)-(iv), for example if there are two or more computer program [product] claims which cannot be considered as falling under one of the exceptions of Rule 43(2) (F-IV, 3.2).

When assessing the novelty and inventive step of a set of claims as defined above (formulations (i)-(iv)), the examiner usually starts with the method claim. If the subject-matter of the method claim is considered novel and inventive, the subject-matter of the other claims in a set formulated in accordance with the headings above will normally be novel and inventive as well, provided they comprise the features corresponding to all those which assure the patentability of the method.

Claims related to CII which are formulated differently to those in the formulations (i)-(iv) defined above are assessed on a case-by-case basis in view of the requirements of clarity, novelty and inventive step (see also F-IV, 3.9.2).

For example, when the invention is realised in a distributed computing environment or involves interrelated products, it may be necessary to refer to the specific features of the different entities and to define how they interact to ensure the presence of all essential features, rather than making a mere reference to another claim as in the above formulations (ii)-(iv). In such cases, further independent claims to interrelated products and their corresponding methods may also be allowable under Rule 43(2)(a) (F-IV, 3.2).

Similarly, if user interaction is required, an objection under Art. 84 may arise if it is not possible to determine from the claim which steps are carried out by the user.

Furthermore, a claim to a computer-implemented data structure in addition to formulations (i)-(iv) may be allowable under Rule 43(2) if it is defined by its own technical features, e.g. by a well-defined structure as in T 858/02, possibly with references to the corresponding method or system in which it is used. However, a computer-implemented data structure does not necessarily comprise features of the process by which it is generated. It is not necessarily restricted by a method in which it is used, either. Therefore, a claim to a computer-implemented data structure usually cannot be defined merely by reference to a method or as an outcome of a process. For further information on data structures, see G-II, 3.7.2.

For the assessment of inventive step for claims comprising features related to exclusions under Art. 52(2), as is often the case with CII, see G-VII, 5.4.

3.9.2 Cases where method steps require specific data processing means and/or require additional technical devices as essential features

Where not all the steps of the method defining the invention can be implemented fully by generic data processing means, defining claims as in formulations (i)-(iv) in F-IV, 3.9.1, may not suffice to fulfil the requirements of Art. 84. Furthermore, in such cases, claims of different categories have to be construed and examined separately with respect to novelty and inventive step.

In particular in applied fields such as medical devices, measuring, optics, electro-mechanics or industrial production processes, method claims frequently involve steps of manipulating or interacting with technical physical entities by using computer control. However, these method steps are not fully performed by the computer and require specific technical means. If the invention involves an interaction between data processing steps and other technical means such as a sensor, an actuator etc., these technical means must be comprised in the independent claims if they are essential for carrying out the invention. An objection under Art. 84 may arise if the claims do not define which steps are carried out by the data processor or by the additional devices involved, as well as their interactions. The same applies if specific data processing means (e.g. a particular parallel computer architecture) are required as opposed to the generic data processing means described in F-IV, 3.9.1.

Example

1. A method of determining oxygen saturation in blood in a pulse oximeter, comprising:

– receiving in an electromagnetic detector first and second electromagnetic radiation signals from a blood-perfused tissue portion corresponding to two different wavelengths of light;

– normalising said electromagnetic signals according to steps A, B and C to provide normalised electromagnetic signals;

– determining oxygen saturation based on said normalised electromagnetic signals according to steps D and E.

2. A pulse oximeter having an electromagnetic detector and means adapted to execute the steps of the method of claim 1.

3. A computer program [product] comprising instructions to cause the device of claim 2 to execute the steps of the method of claim 1.

4. A computer-readable medium having stored thereon the computer program of claim 3.

Remarks: The method has a step which is executed by specific technical means (the electromagnetic detector) for receiving electromagnetic radiation signals. Therefore, the electromagnetic detector has to be defined in the device claim because it is an essential feature for executing the method. In this example, the device claim may make reference to method claim 1, since it is clear how means for executing this method are to be implemented.

However, a computer program making reference only to claim 1 would lack clarity, because such a program could not be executed e.g. on a general-purpose computer which does not have an electromagnetic detector. Therefore, it must be clear from the program that it is to be executed on the specific device of claim 2.

Part G, Chapter II – Patentability, Inventions

3.6 – Programs for Computers

Inventions involving programs for computers can be protected in different forms of a "computer-implemented invention", an expression intended to cover claims which involve computers, computer networks or other programmable apparatus whereby at least one feature is realised by means of a program. Claims directed to computer-implemented inventions may take the forms described in F-IV, 3.9 and sub-sections.

The basic patentability considerations in respect of claims for computer programs are in principle the same as for other subject-matter. While "programs for computers" are included among the items listed in Art. 52(2), if the claimed subject-matter has a technical character it is not excluded from patentability by the provisions of Art. 52(2) and (3).

Technical character should be assessed without regard to the prior art (see T 1173/97, confirmed by G 3/08). Features of the computer program itself (see T 1173/97) as well as the presence of a device defined in the claim (see T 424/03 and T 258/03) may potentially lend technical character to the claimed subject-matter as explained below. In particular in embedded systems, a data processing operation implemented by means of a computer program can equally be implemented by means of special circuits (e.g. by field-programmable gate arrays).

A computer program claimed by itself is not excluded from patentability if it is capable of bringing about, when running on or loaded into a computer, a further technical effect going beyond the "normal" physical interactions between the program (software) and the computer (hardware) on which it is run (T 1173/97 and G 3/08). The normal physical effects of the execution of a program, e.g. electrical currents, are not in themselves sufficient to lend a computer program technical character, and a further technical effect is needed. The further technical effect may be known in the prior art.

Likewise, although it may be said that all computer programming involves technical considerations since it is concerned with defining a method which can be carried out by a machine, that in itself is not enough to demonstrate that the program which results from the programming has technical character; the programmer must have had technical considerations beyond "merely" finding a computer algorithm to carry out some procedure (G 3/08).

A further technical effect which lends technical character to a computer program may be found e.g. in the control of an industrial process or in the internal functioning of the computer itself or its interfaces under the influence of the program and could, for example, affect the efficiency or security of a process, the management of computer resources required or the rate of data transfer in a communication link. A computer program implementing a mathematical method that itself makes a technical contribution (see

G-II, 3.3) would also be considered to be capable of bringing about a further technical effect when it is run on a computer.

Whether a computer program can contribute to the technical character of the claimed subject-matter is frequently an issue separate and distinct from the technical character of the hardware components which may be defined in order to execute the computer program. When a computer program produces a further technical effect (T 1173/97), it is by itself considered technical and not excluded. In contrast, any claimed subject-matter defining or using technical means is an invention within the meaning of Art. 52(1) (see T 424/03 and T 258/03, and confirmed in G 3/08). This applies even if the technical means are commonly known; for example, the inclusion of a computer, a computer network, a readable medium carrying a program, etc. in a claim lends technical character to the claimed subject-matter.

If claimed subject-matter relating to a computer program does not have a technical character, it should be rejected under Art. 52(2) and (3). If the subject-matter passes this test for technicality, the examiner should then proceed to the questions of novelty and inventive step (see G-VI and G-VII).

Appendix E – Patents for Analysis

Table 16 – Complete overview of search results of patents for analysis (Source: Google Patents)

Patent Number	Title	Assignee	Inventor/Author	Priority Date	Publication Date	Grant Date	Use
GB-201801461-D0	Blockchain game	Gorilovskiy Dmitry		2018-01-30	2018-03-14	2018-03-14	No
GB-201800761-D0	Interaction between Blockchains	Setl Development Ltd		2018-01-17	2018-02-28	2018-02-28	No
GB-201800224-D0	ITFSC Blockchain	Singh Arvind, Singularis Vision Ltd		2018-01-08	2018-02-21	2018-02-21	No
GB-201720566-D0	Application design that stores and manages multiple card data securely on mobile devices using Blockchain for authentication of user identity.	Hayzelden Alex, Spirimix Ltd		2017-12-10	2018-01-24	2018-01-24	No
GB-201718361-D0	Decentralised networks of systems and computing methods to exchange transfer aggregate purchase and redeem loyalty reward points underpinned by Blockchain	Ghosh Animesh, Banerjee Sibabrata		2017-11-07	2017-12-20	2017-12-20	No
KR-101812969-B1	System for dealing a digital currency with block chain with preventing security and hacking	주식회사 올아이티탑	최성호, 송청자, 박대진, 김우겸	2017-11-06	2018-01-31	2018-01-31	Yes
US-9882918-B1	User behavior profile in a Blockchain	Forcepoint, LLC	Richard Anthony Ford, Brandon L. Swafford, Christopher Brian Shirey, Matthew P. Moynahan, Richard Heath Thompson	2017-05-15	2018-01-30	2018-01-30	Yes
CN-207123875-U	Based on the block chain technique tachograph	北京网录科技有限公司	张英, 杨涛	2017-09-20	2018-03-20	2018-03-20	Yes
GB-201714841-D0	A system and method for evaluating the feasibility of introducing a new node in a Blockchain infrastructure	Zensar Tech Ltd		2017-01-27	2017-11-01	2017-11-01	No
US-9862222-B1	Digitally encoded seal for document verification	Uipco, Llc	Alexander B. Nagelberg, Michael Justin Cairns	2016-04-04	2018-01-09	2018-01-09	Yes
US-9881176-B2	Fragmenting data for the purposes of persistent storage across multiple immutable data structures	ALTR Solutions, Inc.	Scott Nathaniel Goldfarb, James Douglas Beecham, Christopher Edward Struttmann	2015-06-02	2018-01-30	2018-01-30	No
US-9866545-B2	Credential-free user login to remotely executed applications	ALTR Solutions, Inc.	James Douglas Beecham	2015-06-02	2018-01-09	2018-01-09	No
GB-201709648-D0	Blockchain	Woodenshark Llc		2017-06-16	2017-08-02	2017-08-02	No
US-9832026-B2	System and method from Internet of Things (IoT) security and management	T-Central, Inc.	David W. Kravitz, Donald Houston Graham, III, Josselyn L. Boudett, Russell S. Dietz	2010-04-30	2017-11-28	2017-11-28	No
US-9870508-B1	Securely authenticating a recording file from initial collection through post-production and distribution	Unveiled Labs, Inc.	Roderick Neil Hodgson, Shamir Allibhai	2017-06-01	2018-01-16	2018-01-16	Yes
US-9922381-B2	System and method for providing a payment handler API and a browser payment request API for processing a payment	Monticello Enterprises LLC	Thomas M. Isaacson, Ryan Connell Durham	2014-03-31	2018-03-20	2018-03-20	No
US-9774578-B1	Distributed key secret for rewritable Blockchain	Accenture Global Solutions Limited, GSC Secrypt, LLC	Giuseppe Ateniese, Michael T. Chiaramonte, David Treat, Bernardo Magri, Daniele Venturi	2016-05-23	2017-10-10	2017-10-10	Yes
US-9858781-B1	Architecture for access management	Tyco Integrated Security, LLC	Richard Campero, Sean DAVIS, Graeme Jarvis, Terezinha Rumble	2016-09-09	2018-01-02	2018-01-02	No
US-9849364-B2	Smart device	Bao Tran	Bao Tran, Ha Tran	2016-02-02	2017-12-26	2017-12-26	No
GB-201706950-D0	Automotive electronic Blockchain information system - AEBIS	Cabrera Fernandez Florencio		2017-05-02	2017-06-14	2017-06-14	No
CN-206797615-U	Blockchain coils palm by oneself	东莞市丰锐模型科技有限公司	周二游	2017-04-20	2017-12-26	2017-12-26	No
KR-101774844-B1	Self-learning module of artificial neural network model using neuro-Blockchain combination	주식회사 더디엔에이시스템	윤희병	2017-04-18	2017-09-19	2017-09-19	No

Patent Number	Title	Assignee	Inventor/Author	Priority Date	Publication Date	Grant Date	Use
US-9749140-B2	Systems and methods for managing digital identities	Cambridge Blockchain, LLC	Alex Oberhauser, Matthew Commons, Alok Bhargava	2015-10-14	2017-08-29	2017-08-29	No
US-9912659-B1	Locking systems with multifactor authentication and changing passcodes	Matt Widdows	Matt Widdows	2017-04-14	2018-03-06	2018-03-06	No
CN-206589937-U	Have concurrently and to ride folding deformation formula perambulator that can push away function of to lie	河北工业大学	张建华, 蔡灿, 刘璇, 许晓林, 杨广磊, 李文彬	2017-03-27	2017-10-27	2017-10-27	No
CN-206617519-U	Sandy beach Blockchain strip adjusting device	重庆意驰沙滩车有限公司	李建华	2017-03-24	2017-11-07	2017-11-07	No
US-9716595-B1	System and method for internet of things (IOT) security and management	T-Central, Inc.	David W. Kravitz, Donald Houston Graham, III, Josselyn L. Boudett, Russell S. Dietz	2010-04-30	2017-07-25	2017-07-25	No
US-9888007-B2	Systems and methods to authenticate users and/or control access made by users on a computer network using identity services	Idm Global, Inc.	Jose Caldera, Kieran Sherlock, Garrett Gafke	2016-05-13	2018-02-06	2018-02-06	Yes
CN-206704399-U	Foldable bicycle	天津千岛汽车配件有限公司	胡永刚	2017-03-14	2017-12-05	2017-12-05	No
CN-206682224-U	Stereo garage moves Blockchain strip	淳安千岛湖威猛链条有限公司	余鲜红	2017-03-09	2017-11-28	2017-11-28	No
KR-101784197-B1	System and method of donating using assets including digital virtual money based on Blockchain	유한회사 엘민벤처스	권성민, 서영민, 이시현, 윤석진	2017-03-07	2017-11-06	2017-11-06	Yes
CN-206552175-U	Chain cover plate of bicycle	张纪校	张纪校	2017-03-03	2017-10-13	2017-10-13	No
KR-101763869-B1	Self-composition of artificial neural network model using neuro-Blockchain combination	주식회사 더디엔에이시스템	윤희병	2017-02-16	2017-08-07	2017-08-07	No
KR-101816653-B1	Method for providing login flow via authentication based on public key infrastructure in response to user's login request for using service provided by service provider server in use of smart contract with Blockchain database and server using the same	주식회사 코인플러그	나승일, 김희순, 홍재우, 어준선	2017-02-14	2018-02-21	2018-02-21	No
KR-101816651-B1	Method for providing login flow via authentication based on public key infrastructure in response to user's login request for using service provided by service provider server in use of Blockchain database with unspent transaction output-based protocol and server using the same	주식회사 코인플러그	나승일, 김희순, 홍재우, 어준선	2017-02-14	2018-01-09	2018-01-09	No
KR-101763858-B1	Self-organization of mission using neuro-Blockchain combination	주식회사 더디엔에이시스템	윤희병	2017-02-10	2017-08-14	2017-08-14	No
GB-201702233-D0	Blockchain (ML) Technology	Mollah Stephen		2017-02-09	2017-03-29	2017-03-29	No
US-9794074-B2	Systems and methods for storing and sharing transactional data using distributed computing systems	Nasdaq Technology Ab	Johan TOLL, Fredrik SJÖBLOM	2016-02-04	2017-10-17	2017-10-17	Yes
GB-201701423-D0	Blockchain zero checksum trading system	Cabrera Fernandez Florencio		2017-01-29	2017-03-15	2017-03-15	No
US-9760827-B1	Neural network applications in resource constrained environments	Alpine Electronics of Silicon Valley, Inc.	Rocky Chau-Hsiung Lin, Thomas Yamasaki, Koichiro Kanda, Diego Rodriguez Risco, Alexander Joseph Ryan	2016-07-22	2017-09-12	2017-09-12	No
CN-206394800-U	Helping hand is from road speed sensor	广州市哥得圣电动车有限公司	李宁	2016-12-27	2017-08-11	2017-08-11	No
US-9870591-B2	Distributed electronic document review in a Blockchain system and computerized scoring based on textual and visual feedback	Netspective Communications Llc	Shahid N. Shah	2013-09-12	2018-01-16	2018-01-16	No
CN-206474450-U	Blockchain belt cleaning device	天津众邦泽昱科技发展有限公司	杨世昱	2016-12-10	2017-09-08	2017-09-08	No
US-9824031-B1	Efficient clearinghouse transactions with trusted and un-trusted entities	International Business Machines Corporation	Raghu K. Ganti, Mudhakar Srivatsa, Dinesh C. Verma	2016-10-28	2017-11-21	2017-11-21	Yes
CN-106504008-B	One kind of method is based on a fair contract signing block chain	中山大学	田海博, 付利青	2016-10-24	2017-12-29	2017-12-29	Yes
US-9853819-B2	Blockchain-supported, node ID-augmented digital record signature method	Guardtime Ip Holdings Ltd.	Ahto Truu, Andres Kroonmaa, Michael GAULT, Jeffrey Pearce	2013-08-05	2017-12-26	2017-12-26	Yes

Patent Number	Title	Assignee	Inventor/Author	Priority Date	Publication Date	Grant Date	Use
US-9747586-B1	System and method for issuance of electronic currency substantiated by a reserve of assets	Cpn Gold B.V.	Vladimir Nikolayevich Frolov, Damir Nasibullovich Gaynanov, Aleksey Petrovich Romanchuk, Anatoliy Anatolievich Vatolin	2016-06-28	2017-08-29	2017-08-29	Yes
US-9665734-B2	Uniform-frequency records with obscured context	Q Bio, Inc.	Jeffrey Howard Kaditz, Andrew Gettings STEVENS, David Grijalva	2015-09-12	2017-05-30	2017-05-30	No
US-9875592-B1	Drone used for authentication and authorization for restricted access via an electronic lock	International Business Machines Corporation	Thomas D. Erickson, Kala K. Fleming, Clifford A. Pickover, Komminist Weldemariam	2016-08-30	2018-01-23	2018-01-23	No
CN-206336371-U	Blockchain coils blocking cover connection structure by oneself	天津凯兰德科技股份有限公司	肖猛	2016-08-29	2017-07-18	2017-07-18	No
CN-205951619-U	Inner tube of a tyre Blockchain structure of simple and easy dismouting	王启磊	王启磊	2016-08-15	2017-02-15	2017-02-15	No
US-9807106-B2	Mitigating Blockchain attack	British Telecommunications Public Limited Company	Joshua DANIEL, Gery Ducatel, Theo Dimitrakos	2015-07-31	2017-10-31	2017-10-31	Yes
CN-205918851-U	Fortune mould Blockchain strip hydraulic cylinder mechanism	邯郸金狮棉机有限公司	张剑飞, 郭大伟, 苗才华, 翟鸿鹄, 董春强, 杨璨	2016-07-18	2017-02-01	2017-02-01	No
US-9702582-B2	Connected thermostat for controlling a climate system based on a desired usage profile in comparison to other connected thermostats controlling other climate systems	Ikorongo Technology, LLC	Hugh Blake Svendsen	2015-10-12	2017-07-11	2017-07-11	No
CN-205854345-U	Blockchain coils illuminator by oneself	姚永均	姚永均	2016-07-15	2017-01-04	2017-01-04	No
KR-101795696-B1	Method for providing archiving and verification services of data transceived via messenger service and server using the same	주식회사 코인플러그	홍재우, 어준선, 송주한	2016-07-14	2017-11-09	2017-11-09	No
KR-101795695-B1	Method for providing archiving service and verification service of data transceived via messenger service and server using the same	주식회사 코인플러그	홍재우, 어준선, 송주한	2016-07-14	2017-12-01	2017-12-01	No
GB-201611698-D0	Blockchain-implemented control method and system	Eitc Holdings Ltd		2016-07-05	2016-08-17	2016-08-17	No
GB-201611697-D0	Blockchain-implemented control method and system	Eitc Holdings Ltd		2016-07-05	2016-08-17	2016-08-17	No
CN-205890835-U	Can press from both sides by fixed washing Blockchain chain	浙江工业职业技术学院	吴婷婷, 孙艺榕	2016-06-23	2017-01-18	2017-01-18	No
NL-2016935-B1	Method and device for controlling at least one electric apparatus	Peeeks B V	Wouter Joghum Robers Egbert, Marc Vermeer Kaz, Lucas Jorrit	2016-06-10	2018-01-16	2018-01-16	Yes
KR-101807518-B1	Electronic securities marketing management system and method for startup	주식회사 피노텍	김우섭	2016-06-09	2017-12-12	2017-12-12	No
US-9569771-B2	Method and system for storage and retrieval of Blockchain blocks using galois fields	Stephen Lesavich, Zachary C. LESAVICH	Stephen Lesavich, Zachary C. LESAVICH	2011-04-29	2017-02-14	2017-02-14	No
US-9635000-B1	Blockchain identity management system based on public identities ledger	Sead Muftic	Sead Muftic	2016-05-25	2017-04-25	2017-04-25	Yes
KR-101780636-B1	Method for issuing certificate information and Blockchain-based server using the same	주식회사 코인플러그	송주한, 홍재우, 어준선	2016-05-16	2017-09-21	2017-09-21	No
KR-101799343-B1	Method for using, revoking certificate information and Blockchain-based server using the same	주식회사 코인플러그	송주한, 홍재우, 어준선	2016-05-16	2017-11-22	2017-11-22	No
US-9722790-B2	Identity management service using a Blockchain providing certifying transactions between devices	ShoCard, Inc.	Armin Ebrahimi	2015-05-05	2017-08-01	2017-08-01	No
GB-201607584-D0	Implementing logic gate functionality using a Blockchain	Eitc Holdings Ltd		2016-04-29	2016-06-15	2016-06-15	No
GB-201607561-D0	Implementing logic gate functionality using a Blockchain	Eitc Holdings Ltd		2016-04-29	2016-06-15	2016-06-15	No
GB-201607566-D0	Implementing logic gate functionality using a Blockchain	Eitc Holdings Ltd		2016-04-29	2016-06-15	2016-06-15	No
GB-201607569-D0	Implementing logic gate functionality using a Blockchain	Eitc Holdings Ltd		2016-04-29	2016-06-15	2016-06-15	No
GB-201607520-D0	Implementing logic gate functionality using a Blockchain	Eitc Holdings Ltd		2016-04-29	2016-06-15	2016-06-15	No
GB-201607541-D0	Implementing logic gate functionality using a Blockchain	Eitc Holdings Ltd		2016-04-29	2016-06-15	2016-06-15	No
GB-201607553-D0	Implementing logic gate functionality using a Blockchain	Eitc Holdings Ltd		2016-04-29	2016-06-15	2016-06-15	No
GB-201607538-D0	Implementing logic gate functionality using a Blockchain	Eitc Holdings Ltd		2016-04-29	2016-06-15	2016-06-15	No
GB-201607537-D0	Implementing logic gate functionality using a Blockchain	Eitc Holdings Ltd		2016-04-29	2016-06-15	2016-06-15	No

Patent Number	Title	Assignee	Inventor/Author	Priority Date	Publication Date	Grant Date	Use
GB-201607564-D0	Implementing logic gate functionality using a Blockchain	Eitc Holdings Ltd		2016-04-29	2016-06-15	2016-06-15	No
GB-201607529-D0	Implementing logic gate functionality using a Blockchain	Eitc Holdings Ltd		2016-04-29	2016-06-15	2016-06-15	No
GB-201607539-D0	Implementing logic gate functionality using a Blockchain	Eitc Holdings Ltd		2016-04-29	2016-06-15	2016-06-15	No
GB-201607558-D0	Implementing logic gate functionality using a Blockchain	Eitc Holdings Ltd		2016-04-29	2016-06-15	2016-06-15	No
GB-201607552-D0	Implementing logic gate functionality using a Blockchain	Eitc Holdings Ltd		2016-04-29	2016-06-15	2016-06-15	No
GB-201607555-D0	Implementing loic gate functionality using a Blockchain	Eitc Holdings Ltd		2016-04-29	2016-06-15	2016-06-15	No
GB-201607530-D0	Implementing logic gate functionality using a Blockchain	Eitc Holdings Ltd		2016-04-29	2016-06-15	2016-06-15	No
GB-201607476-D0	Operating system for Blockchain IOT devices	Eitc Holdings Ltd		2016-04-29	2016-06-15	2016-06-15	Yes
GB-201607554-D0	Implementing logic gate functionality using a Blockchain	Eitc Holdings Ltd		2016-04-29	2016-06-15	2016-06-15	No
GB-201607527-D0	Implementing logic gate functionality using a Blockchain	Eitc Holdings Ltd		2016-04-29	2016-06-15	2016-06-15	No
GB-201607472-D0	Implementing logic gate functionality using a Blockchain	Eitc Holdings Ltd		2016-04-29	2016-06-15	2016-06-15	No
GB-201607525-D0	Implementing logic gate functionality using a Blockchain	Eitc Holdings Ltd		2016-04-29	2016-06-15	2016-06-15	No
KR-101701131-B1	Data recording and validation methods and systems using the connecting of Blockchain between different type	주식회사 라피	김영랑	2016-04-28	2017-02-13	2017-02-13	No
US-9513627-B1	Autonomous coordination of resources amongst robots	inVia Robotics, LLC	Lior Elazary, Randolph Charles Voorhies, Frank Parks II Daniel	2016-04-25	2016-12-06	2016-12-06	Yes
GB-201605331-D0	Blockchain state reliability determination	British Telecomm		2016-03-30	2016-05-11	2016-05-11	No
CN-205417922-U	Electric motor car of small -size transportation goods	南昌工程学院	潘延鑫, 徐源, 井思媛, 徐加兴, 冯匡, 任月	2016-03-30	2016-08-03	2016-08-03	No
GB-201605026-D0	Secure multiparty loss resistant storage and transfer of cryptographic keys for Blockchain based systems in conjunction with a wallet management system	Eitc Holdings Ltd		2016-03-24	2016-05-11	2016-05-11	No
US-9558524-B2	Risk assessment using social networking data	Socure Inc.	Sunil Madhu, Giacomo Pallotti, Edward J. Romano, Alexander K. Chavez	2013-03-15	2017-01-31	2017-01-31	No
GB-201604497-D0	Method and system for generating records of entities on a peer-to-peer distributed ledger that can be used in the creation of a Blockchain complete based	Eitc Holdings Ltd		2016-03-16	2016-04-27	2016-04-27	No
GB-201604493-D0	Methods and systems for efficient transfer of entities on a peer-to-peer distributed ledger using the Blockchain	Eitc Holdings Ltd		2016-03-16	2016-04-27	2016-04-27	No
KR-101694455-B1	Method and apparatus for exchanging or remitting Blockchain-based virtual currency	주식회사 스트리미	윤준식, 공윤진, 이승명, 김민환	2016-03-14	2017-01-17	2017-01-17	Yes
US-9509690-B2	Methods and systems for managing network activity using biometrics	Eyelock Llc	Samuel J. Carter, Christopher L. Ream, Sarvesh Makthal, Stephen Charles Gerber	2015-03-12	2016-11-29	2016-11-29	No
GB-201604219-D0	Enhanced Blockchain architecture and protocol that leads to the infinite scaling of payment networks in real time for bitcoin with segregated merchant markets	Eitc Holdings Ltd		2016-03-11	2016-04-27	2016-04-27	No
GB-201604227-D0	Authorisation method and system for the transfer of tokens on a Blockchain and the redemption of contracts in web of trust	Eitc Holdings Ltd		2016-03-11	2016-04-27	2016-04-27	No
GB-201604225-D0	Method and system for the efficient transfer of tokens on a Blockchain based on a codification process	Eitc Holdings Ltd		2016-03-11	2016-04-27	2016-04-27	No
GB-201604244-D0	Methods and systems for efficient transfer of entities on a peer-to-peer distributed ledger using the Blockchain	Eitc Holdings Ltd		2016-03-11	2016-04-27	2016-04-27	No
GB-201603114-D0	Agent-based turing complete transactions integrating feedback within a Blockchain system	Eitc Holdings Ltd		2016-02-23	2016-04-06	2016-04-06	No
GB-201603112-D0	Blockchain implemented counting system and method for use in secure voting and distribution	Eitc Holdings Ltd		2016-02-23	2016-04-06	2016-04-06	No
GB-201603117-D0	Determining a common secret for two Blockchain nodes for the secure exchange of information	Eitc Holdings Ltd		2016-02-23	2016-04-06	2016-04-06	No
GB-201603125-D0	Universal tokenisation system for Blockchain based cryptocurrencies	Eitc Holdings Ltd		2016-02-23	2016-04-06	2016-04-06	No

Patent Number	Title	Assignee	Inventor/Author	Priority Date	Publication Date	Grant Date	Use
US-9825931-B2	System for tracking and validation of an entity in a process data network	Bank Of America Corporation	Darrell Johnsrud, Manu Jacob Kurian, Michael Wuehler	2016-01-26	2017-11-21	2017-11-21	Yes
GB-201602813-D0	Agent-based turing complete transactions integrating feedback within a Blockchain system	Ncip Holdings Ltd		2016-02-17	2016-03-30	2016-03-30	No
GB-201602807-D0	Universal tokenisation system for Blockchain based cryptocurrencies	Ncip Holdings Ltd		2016-02-17	2016-03-30	2016-03-30	No
GB-201602806-D0	Determining a common secret for two Blockchain nodes for the secure exchange of information	Ncip Holdings Ltd		2016-02-17	2016-03-30	2016-03-30	No
GB-201602814-D0	Blockchain implemented counting system and method for use in secure voting and distribution	Ncip Holdings Ltd		2016-02-17	2016-03-30	2016-03-30	No
US-9853977-B1	System, method, and program product for processing secure transactions within a cloud computing system	Winklevoss Ip, Llc	Andrew Laucius, Cem Paya, Eric Winer	2015-01-26	2017-12-26	2017-12-26	No
CN-205389272-U	Intelligence luggage	罗轶	罗轶	2016-01-17	2016-07-20	2016-07-20	No
CN-205362056-U	Single pole washing car	浙江隆源环境科技股份有限公司	周立钢, 周立峰, 董显维, 朱德良	2015-12-30	2016-07-06	2016-07-06	No
US-9705682-B2	Extending DNSSEC trust chains to objects outside the DNS	Verisign, Inc.	Burton S. Kaliski, Jr., Eric Osterweil, Glen Wiley	2015-07-06	2017-07-11	2017-07-11	No
US-9818116-B2	Systems and methods for detecting relations between unknown merchants and merchants with a known connection to fraud	Idm Global, Inc.	Jose Caldera	2015-11-11	2017-11-14	2017-11-14	No
KR-101689815-B1	Financial transaction service system using virtual sharing account	김민찬	김민찬	2015-11-20	2016-12-27	2016-12-27	No
US-9847997-B2	Server based biometric authentication	Visa International Service Association	Kim Wagner	2015-11-11	2017-12-19	2017-12-19	Yes
US-9852427-B2	Systems and methods for sanction screening	Idm Global, Inc.	Jose Caldera	2015-11-11	2017-12-26	2017-12-26	No
US-9792101-B2	Capacity and automated de-install of linket mobile apps with deep links	Wesley John Boudville	Wesley John Boudville	2015-11-10	2017-10-17	2017-10-17	No
US-9480188-B2	Use of computationally generated thermal energy	LO3 Energy Inc.	Lawrence Orsini, Yun Wei	2014-11-04	2016-10-25	2016-10-25	No
CN-205059820-U	Blockchain dish semicircle encircles baffle by oneself	方闻轩	方闻轩	2015-10-28	2016-03-02	2016-03-02	No
CN-205113544-U	Blockchain dish pitch arc keeps off by oneself	方闻轩	方闻轩	2015-10-28	2016-03-30	2016-03-30	No
CN-205168731-U	Rain -proof formula theftproof bicycle of saddle	同济大学	陈卫东, 李永记, 詹澎明	2015-10-28	2016-04-20	2016-04-20	No
GB-201517581-D0	A Transferable value or rights token authenticated using a Blockchain	Everett David And Owen John And Jones Timothy		2015-10-06	2015-11-18	2015-11-18	Yes
GB-201517541-D0	A Transferable Value or Rights Token Authenticated Using a Blockchain	Everett David And Owen John And Jones Timothy		2015-10-05	2015-11-18	2015-11-18	No
CN-204982434-U	Body -building type washing machine	苏比江·艾尔肯	苏比江·艾尔肯	2015-09-30	2016-01-20	2016-01-20	No
CN-205010425-U	Repair bicycle device	吴震	吴震	2015-09-28	2016-02-03	2016-02-03	No
CN-205059834-U	Folding bicycle of running -board	杨心辉	杨心辉, 高龙关, 叶小娣, 周兆麒	2015-09-07	2016-03-02	2016-03-02	No
US-9703986-B1	Decentralized reputation service for synthetic identities	Anonyome Labs, Inc.	Paul Ashley, Steve Shillingford, Greg Clark, Dennis Wilkins, Mike Neuenschwander, Stephen Sartor	2015-05-13	2017-07-11	2017-07-11	Yes
CN-204895741-U	Body -building bicycle	南京工业职业技术学院	汪玮玮, 王志刚	2015-08-10	2015-12-23	2015-12-23	No
CN-204913356-U	Motor Blockchain dish processing graduation positioner	重庆诚硕科技有限公司	陈佳英	2015-08-07	2015-12-30	2015-12-30	No
US-9836908-B2	System and method for securely receiving and counting votes in an election	Blockchain Technologies Corporation	Nikolaos Spanos, Andrew R. Martin, Eric T. Dixon	2014-07-25	2017-12-05	2017-12-05	Yes
GB-201513626-D0	Mitigating Blockchain attack	British Telecomm		2015-07-31	2015-09-16	2015-09-16	No
US-9705851-B2	Extending DNSSEC trust chains to objects outside the DNS	Verisign, Inc.	Burton S. Kaliski, Jr., Eric Osterweil, Glen Wiley	2015-07-06	2017-07-11	2017-07-11	No
US-9608829-B2	System and method for creating a multi-branched Blockchain with configurable protocol rules	Blockchain Technologies Corporation	Nikolaos Spanos, Andrew R. Martin, Eric T. Dixon, Asterios Steven Geros	2014-07-25	2017-03-28	2017-03-28	Yes

Patent Number	Title	Assignee	Inventor/Author	Priority Date	Publication Date	Grant Date	Use
US-9298806-B1	System and method for analyzing transactions in a distributed ledger	Coinlab, Inc.	Peter Joseph Vessenes, Robert Beach Seidensticker, III	2015-07-08	2016-03-29	2016-03-29	Yes
CN-204760712-U	Rotatable socket	宁波市镇海乌托邦工业设计有限公司	王博	2015-07-01	2015-11-11	2015-11-11	No
US-9351124-B1	Location detection and communication through latent dynamic network interactions	Cognizant Business Services Limited	Edward Martin Shelton	2015-06-29	2016-05-24	2016-05-24	No
CN-204754379-U	Unpowered year car parking stall device	陕西隆翔停车设备集团有限公司	朱先德, 冯小隆, 刘群, 隋永海, 路海博	2015-06-15	2015-11-11	2015-11-11	No
US-9870562-B2	Method and system for integration of market exchange and issuer processing for Blockchain-based transactions	Mastercard International Incorporated	Steven Charles DAVIS, Ashish Raghavendra Tetali	2015-05-21	2018-01-16	2018-01-16	Yes
CN-204775692-U	Multi -functional climbing bicycle	天津市天昌琴瑶自行车有限公司	张俊玲	2015-05-21	2015-11-18	2015-11-18	No
US-9875510-B1	Consensus system for tracking peer-to-peer digital records	Lance Kasper	Lance Kasper	2015-02-03	2018-01-23	2018-01-23	Yes
CN-204570565-U	Device for leak protection Blockchain strip of sweeping floor conveying	浙江跃华沃城电动车有限公司	王朝圣, 连建国	2015-04-28	2015-08-19	2015-08-19	No
US-9397985-B1	System and method for providing a cryptographic platform for exchanging information	Manifold Technology, Inc.	A. Seger II Robert, Christopher T. Finan	2015-04-14	2016-07-19	2016-07-19	Yes
US-9667600-B2	Decentralized and distributed secure home subscriber server device	At&T Intellectual Property I, L.P.	Roger Piqueras Jover, Joshua Lackey	2015-04-06	2017-05-30	2017-05-30	Yes
US-9876775-B2	Generalized entity network translation (GENT)	Ent Technologies, Inc.	Timothy Mossbarger	2012-11-09	2018-01-23	2018-01-23	Yes
CN-204508007-U	Spill the skip chain tight device that rises	安徽安凯金达机械制造有限公司	金鑫, 杨毅, 严清, 张军鸿, 王凯	2015-03-23	2015-07-29	2015-07-29	No
US-9436935-B2	Computer system for making a payment using a tip button	Coinbase, Inc.	James Bradley Hudon	2014-03-17	2016-09-06	2016-09-06	Yes
US-9641338-B2	Method and apparatus for providing a universal deterministically reproducible cryptographic key-pair representation for all SKUs, shipping cartons, and items	Skuchain, Inc.	Srinivasan Sriram, Zaki N. MANIAN	2015-03-12	2017-05-02	2017-05-02	No
KR-101673073-B1	Dealing method of Crypto-currency base on Blockchain System	이진희	이진희	2015-02-25	2016-11-04	2016-11-04	No
CN-204587144-U	Multifunctional power-storage bicycle	三合顺（天津）电子科技有限公司	曹建芹	2015-02-05	2015-08-26	2015-08-26	No
US-9413735-B1	Managing distribution and retrieval of security key fragments among proxy storage devices	Ca, Inc.	Geoffrey R. Hird	2015-01-20	2016-08-09	2016-08-09	No
CN-204572836-U	Transmission shaft of universal joint	重庆钰康机械有限公司	沈文, 李宗昭, 胡朝勇	2015-01-12	2015-08-19	2015-08-19	No
US-9749297-B2	Manicoding for communication verification	Yaron Gvili	Yaron Gvili	2014-11-12	2017-08-29	2017-08-29	No
US-9710808-B2	Direct digital cash system and method	Igor V. SLEPININ	Igor V. SLEPININ	2013-09-16	2017-07-18	2017-07-18	No
US-9014661-B2	Mobile security technology	Christopher deCharms	Christopher deCharms	2013-05-04	2015-04-21	2015-04-21	No
US-9760574-B1	Managing I/O requests in file systems	EMC IP Holding Company LLC	Jia Zhai, Yingchao Zhou, Ivan Bassov	2014-06-30	2017-09-12	2017-09-12	No
US-9898782-B1	Systems, methods, and program products for operating exchange traded products holding digital math-based assets	Winklevoss Ip, Llc	Cameron Howard Winklevoss, Tyler Howard Winklevoss, Evan Louis Greebel, Kathleen Hill Moriarty, Gregory Elias Xethalis	2013-06-28	2018-02-20	2018-02-20	No
US-9818092-B2	System and method for executing financial transactions	Antti Pennanen	Antti Pennanen	2014-06-04	2017-11-14	2017-11-14	No
US-9135787-B1	Bitcoin kiosk/ATM device and system integrating enrollment protocol and method of using the same	Mark Russell, John W. Russell	Mark Russell, John W. Russell	2014-04-04	2015-09-15	2015-09-15	Yes
US-9331856-B1	Systems and methods for validating digital signatures	Symantec Corporation	Qu Bo Song	2014-02-10	2016-05-03	2016-05-03	No
US-9338148-B2	Secure distributed information and password management	Verizon Patent And Licensing Inc., Cellco Partnership	Donna L. Polehn, Lalit R. KOTECHA, Patricia R. Chang, Deepak Kakadia, John F. MACIAS, Priscilla Lau, Arda Aksu	2013-11-05	2016-05-10	2016-05-10	Yes

Appendix F – Patent Analysis

Table 17 - Selection of patents for patent analysis (Source: Google Patents)

#	Patent Number	Priority Date	Claimed Part of Technology	Preamble(s)	Type of preamble(s)	No. of ICs	Transitional Phrase(s)
1	(Korea Patentnr. KR101812969B1, 2017)	6-11-2017	?	1) A method of the transaction in which the block chain encrypted money without the issuing body of the currency in a structure collects the encrypted transfer recording made in the network	1) Method	1	?
2	(China Patentnr. CN207123875U, 2017)	20-9-2017	?	?	?	?	Open
3	(United States of America Patentnr. US9870508B1, 2018)	1-6-2017	Distributed Ledger	1) A method of securely authenticating a recording file from initial collection through post-production and distribution 2) A system including one or more processors coupled to memory, the memory loaded with computer instructions to securely authenticate a recording file from initial collection through post-production and distribution, the instructions, when executed on the processors, implement actions 3) A non-transitory computer readable storage medium impressed with computer program instructions to securely authenticate a recording file from initial collection through post-production and distribution, the instructions, when executed on a processor, implement a method	1) Method 2) System 3) Computer readable storage medium	3	Open
4	(United States of America Patentnr. US9882918B1, 2018)	15-5-2017	Technical Effect	1) A computer im (Korea Patentnr. KR101812969B1, 2017)plementable method for generating a cyber behaviour profile 2) A system 3) A non-transitory computer readable storage medium embodying computer program code	1) Method 2) System 3) Computer readable storage medium	3	Open
5	(Korea Patentnr. KR101784197B1, 2017)	7-3-2017	?	?	?	?	?
6	(United States of America Patentnr. US9824031B1, 2017)	28-10-2016	Distributed Ledger	1) A method implemented by at least one hardware processor of coalescing transactions between trusted and un-trusted parties 2) A system 3) A non-transitory computer readable storage medium	1) Method 2) System 3) Storage medium	3	Open
7	(China Patentnr. CN106504008B, 2016)	24-10-2016	?	1) A method	1) Method	1	Open
8	(United States Patentnr. US9747586B1, 2017)	28-6-2016	Technical Effect	1) A computer-based system for issuing and managing electronic currency substantiated by a gold reserve 2) A non-transitory, computer readable medium storing computer-executable instructions for issuing and managing electronic currency substantiated by a gold reserve	1) System 2) Computer readable storage medium	2	Open
9	(Netherlands Patentnr. NL2016935B1, 2016)	10-6-2016	Technical Effect	1) A device for controlling at least one electronic apparatus 2) A method for controlling at least one electronic apparatus	1) Device 2) Method	2	Open
10	(United States of America Patentnr. US9635000B1, 2017)	25-5-2016	Both	1) A system for managing identities of entities in a computer network 2) A method for managing identities of entities associated with an electronic append-only public identities ledger maintained at a plurality of electronic computing devices in a computer network 3) A system for managing identities of entities in a computer network	1) System 2) Method 3) System	3	Open

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11	(United States of America Patentnr. US9774578B1, 2017)	23-5-2016	Distributed Ledger	1) A system 2) A method 3) A product	1) System 2) Method 3) product	3	Open
12	(United States of America Patentnr. US9888007B2, 2018)	13-5-2016	Technical Effect	1) A controller for user authentication and access control 2) A controller for user authentication and access control 3) A controller for user authentication and access control 4) A controller for user authentication and access control 5) A non-transitory computer storage medium, storing instructions which, when executed by a controller, cause the controller to perform a method for user authentication and access control 6) A method for user authentication and access control	1) Controller 2) Controller 3) Controller 4) Controller 5) Computer storage medium 6) Method	6	Open
13	(Great Britain Patentnr. GB201607476D0, 2017)	29-4-2016	Technical Effect	1) A computer-implemented control system for controlling a device 2) A computer-implemented control method for controlling a device	1) System 2) Method	2	Open
14	(United States of America Patentnr. US9513627B1, 2016)	25-4-2016	Technical Effect	1) A method 2) A method 3) A method	1) Method 2) Method 3) Method	3	Open
15	(United States of America Patentnr. US9862222B1, 2018)	4-4-2016	Technical Effect	1) A seal application device 2) A computer-implemented method performed by at least one processor 3) One or more computer-readable media storing instructions which, when executed by at least one processor, cause the at least one processor to perform operations	1) Device 2) Method 3) Computer readable storage media	3	Open
16	(Korea Patentnr. KR101694455B1, 2016)	14-3-2016	?	1) A method 2) Means (method) for generating first information including a plurality of short arc, and a plurality of long number of the first currency for the digital virtual currency	1) Method 2) Method	2	Open
17	(United States of America Patentnr. US9794074B2, 2017)	4-2-2016	Technical Effect	1) A computer system configured to communicate with a distributed Blockchain computer system that includes multiple computing nodes, each computing node configured to store a copy, or a portion thereof, of a Blockchain of the distributed Blockchain computer system 2) A non-transitory computer readable storage medium storing instructions for use with a computer system that includes a transceiver and a storage system, the computer system configured to communicate with a distributed Blockchain computer system that includes multiple computing nodes, each computing node configured to store a copy, or a portion thereof, of a Blockchain of the distributed Blockchain computer system, the storage system configured to store a data structure for a plurality of accounts, each one of the plurality of accounts including at least a private key an a public key, the plurality of accounts including an intermediary account, where the first and second identifiers are associated, respectively, with first and second accounts of the plurality of accounts 3) A method for interacting with a Blockchain using a computer system that includes a transceiver and a storage system configured to store a data structure for a plurality of accounts including an intermediary account, where the first and second accounts of the plurality of accounts	1) System 2) Computer readable storage medium 3) Method	3	Open
18	(United States of America Patentnr. US9825931B2, 2017)	26-1-2016	Technical Effect	1) A system for tracking and validating instances of a user 2) A computer program product for tracking and validating instances of a user, the computer program product comprising at least one non-transitory computer-readable medium 3) A computer-implemented method for tracking and validating instances of a user	1) System 2) Computer program 3) Method	3	Open

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19	(United States of America Patentnr. US9847997B2, 2017)	11-11-2015	Technical Effect	1) A method for biometric authentication 2) An identity (ID) manager computer for biometric authentication 3) A method for biometric authentication	1) Method 2) An identity manager 3) Method	3	Open
20	(Great Britain Patentnr. GB201517581D0, 2017)	6-10-2015	Both	1) An electronic value transfer system 2) A non-transitory storage medium storing software instructions	1) System 2) Storage medium	2	Open
21	(United States of America Patentnr. US9807106B2, 2017)	31-7-2015	Technical Effect	1) A computer implemented method for detecting malicious attacks presenting a threat to a Blockchain associated with a Blockchain data structure of a computing device 2) A computer system to detect malicious attacks presenting a threat to a Blockchain structure	1) Method 2) System	2	Open
22	(United States of America Patentnr. US9298806B1, 2016)	8-7-2015	Distributed Ledger	1) A system for analysing transactions in a distributed ledger 2) A method for analyzing transactions in a distributed ledger, the method being implemented on a computer system having one or more physical processors configured by machine-readable instructions which, when executed, perform the method	1) System 2) Method	2	Open
23	(United States of America Patentnr. US9870562B2, 2018)	21-5-2015	Technical Effect	1) A method for authorization of a Blockchain transaction 2) A system for authorization of a Blockchain transaction	1) Method 2) System	2	Open
24	(United States of America Patentnr. US9703986B1, 2017)	13-5-2015	Both	1) A machine	1) Machine	1	Open
25	(United States of America Patentnr. US9397985B1, 2016)	14-4-2015	Distributed Ledger	1) A system for providing a cryptographic platform for exchanging information 2) A method for providing a cryptographic platform for exchanging information	1) System 2) Method	2	Open
26	(United States of America Patentnr. US9667600B2, 2017)	6-4-2015	Both	1) A device 2) A method 3) A non-transitory computer-readable storage medium	1) Device 2) Method 3) Computer readable storage medium	3	Open
27	(United States of America Patentnr. US9875510B1, 2018)	3-2-2015	Distributed Ledger	1) A decentralized consensus system for tracking transferable digital objects	1) System	1	Open
28	(United States of America Patentnr. US9836908B2, 2017)	25-7-2014	Technical Effect	1) A voting system 2) A computer implemented method of securing voting data	1) System 2) Method	2	Open
29	(United States of America Patentnr. US9608829B2, 2017)	25-7-2014	Distributed Ledger	1) A method of securely storing data across a network in a multi-dimensional distributed database 2) A system for securely storing data across a network in a multi-dimensional distributed database	1) Method 2) System	2	Open

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30	(United States of America Patentnr. US9135787B1, 2015)	4-4-2014	Technical Effect	1) A kiosk device 2) A method of facilitating digital transactions at an electronic kiosk 3) A kiosk device 4) A method of facilitating digital transactions	1) Device 2) Method 3) Device 4) Method	4	Open
31	(United States of America Patentnr. US9436935B2, 2016)	17-3-2014	Both	1) A host computer system 2) A method of transferring funds	1) System 2) Method	2	Open
32	(United States of America Patentnr. US9338148B2, 2016)	5-11-2013	Distributed Ledger	1) A method, performed by a computer device 2) A computer device 3) A non-transitory computer-readable memory device storing instructions executable by a processor	1) Method 2) Device 3) Computer readable memory device	3	Open
33	(United States of America Patentnr. US9853819B2, 2017)	5-8-2013	Distributed Ledger	1) A method for authenticating digital records	1) Method	1	Open
34	(United States of America Patentnr. US9876775B2, 2018)	9-11-2012	Distributed Ledger	1) A method for creating trusted authentic digital relationships in a computer network using a unique electronic entity identifier for an entity including, but not limited to a person, abstract entity, datum, good, or electronic device 2) A method for authenticating a unique entity identifier for an entity including, but not limited to a person, abstract entity, datum, good, or electronic device	1) Method 2) Method	2	Open