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WHEN OPEN SOURCE SOFTWARE ENCOUNTERS PATENTS: BLOCKCHAIN AS AN EXAMPLE TO EXPLORE THE DILEMMA AND SOLUTIONS

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ABSTRACT

The original blockchain developers set the core programs, development interfaces, and application software of the blockchain as open source software, which are open to all developers for free. They have never thought of collecting royalties by claiming copyright, nor did they apply for patents. Since then, however, many follow-up blockchain developers applied the core programs to further developments and filed a large numbers of patent applications, causing the original blockchain developers to be very concerned about whether these patents will otherwise slow down or even endanger the innovation of blockchain technology. Consequently, finding legal solutions for the conflicts between open source software and patent rights hence becomes an important research topic in the field of intellectual property rights.

This article discusses three possible solutions to the conflict: the licensing schemes of industrial standard, the licensing schemes of open source software, and the open patent campaigns, pointing out that at the moment all three have an opportunity to solve the problem, while also acknowledging that there are still many issues to be solved. In terms of the licensing schemes of industrial standard, this article considers that the industrial standard of blockchain should require the patentees involved in standard setting to disclose their patents, and should require the owners of the standard essential patents to not refuse the patent licensing. To determine what licensing scheme the blockchain standard should adopt, this article conducts a legal and economic analysis by studying its technical attributes, the process of patent thicketing, and the development of the industry, suggesting that the "Patent Policy" of the blockchain standard should at least follow the fair, reasonable, and non-discriminatory (FRAND) license adopted by many industrial standards such as the telecommunication industry. As a result, users of blockchain could access the patented technologies more conveniently. In terms of the licensing schemes of open source software, this article finds that the MIT license for the Bitcoin Blockchain and the GNU GPL license for the Ethereum Blockchain cannot solve the problem of follow-up developers not drafting a software code, but instead applying for patents for the resulting follow-up developments. This article compares the similarities and differences of other open source software programs, studies the original philosophical spirit and technological and industrial development of blockchains, and suggests a suitable licensing scheme of open source software for the blockchain technology.

Lastly, this article finds open patents to be a possible solution to the patent problems faced by the blockchain technology, but concludes that this solution is more challenging with blockchain than in

other industries because open patent campaigns rely on the spontaneous action of the patentee. The blockchain industry, especially the original developers of the core blockchain technology, should provide incentives for the right holders of subsequent patent applications to willingly and spontaneously open their patents.

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I. INTRODUCTION

Finding a legal solution for the conflicts between open source software and patent rights is an important, but less-mentioned research topic in the field of intellectual property rights. The newly developing blockchain technology provides a good case study to explore the dilemma and find solutions.

The blockchain is the bottom-layer technology of Bitcoin, which is the first cryptocurrency invented by a person named Satoshi Nakamoto in 2008.[1] Blockchain is a decentralized, peer-to-peer network architecture, functioning as both network and database.[2] Because the scripting language of the blockchain for Bitcoin is not turing-complete, it has very limited programming capability.[3] Therefore, Bitcoin's most important application is to serve as an online digital currency.[4] Before the Bitcoin is recognized as legal currency by governments around the world, its commercial applications are limited and not taken seriously.

At the end of 2013, a Canadian computer genius only 19 years old by the name of Vitalik Buterin founded Ethereum, which is a type of blockchain different from that of Bitcoin.[5] The software of Ethereum is turing-complete with a more functional scripting language,[6] allowing users to write and deploy smart contracts.[7] Ethereum develops a couple of programing languages for users to write smart contracts and provides an environment for deploying and executing the smart contracts in the blockchain. Users can write a smart contract using one of the programming languages to transform a real contract to a programming code, and in turn deploy the

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[1] Satoshi Nakamoto, *Bitcoin: A Peer-to-Peer Electronic Cash System*, https://bitcoin.org/bitcoin.pdf (last visited May 29, 2018).

[2] Marcus O'Dair, *Music on the Blockchain, Blockchain For Creative Industries Research Cluster* (Middlesex University, 2016), https://www.mdx.ac.uk/__data/assets/pdf_file/0026/230696/Music-On-The-Blockchain.pdf.

[3] Marcin Andrychowicz, Stefan Dziembowski, Daniel Malinowski & Łukasz Mazurek, *Secure Multiparty Computations on Bitcoin*, 2014 IEEE Symposium on Security and Privacy 443, 448, http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=6956580 (last visited May 29, 2018).

[4] Gregory M. Karch, *Bitcoin, the Law and Emerging Public Policy: Towards a 21st Century Regulatory Scheme*, 10 FLA. A&M U.L. REV. 193, 195 (2014).

[5] Nick Vogel, T*he Great Decentralization: How Web 3.0 Will Weaken Copyrights*, 15 J. MARSHALL REV. INTELL. PROP. L. 136, 140 (2015).

[6] Michael Abramowicz, *Cryptocurrency-Based Law*, 58 ARIZ. L. REV. 359, 362 (2016).

[7] Vitalik Buterin, *Ethereum White Paper*, GITHUB, https://github.com/ethereum/wiki/wiki/White-Paper#ethereum-accounts (last visited May 29, 2018).

code into the Ethereum for automated execution.[8] Based on Ethereum and smart contracts, more and more financial applications have been developed in recent years that are likely to overturn the current business models in the banking and insurance industries.

Like the other blockchains such as the blockchain of Bitcoin, Ethereum is an open source platform, allowing all users to develop many kinds of applications on it with zero licensing fees. In order to implement the belief and purpose of open source software, Ethereum's inventor and founder never tried to collect royalties by claiming copyright, nor filed any patent applications to protect the invention of Ethereum and smart contracts. However, as the enormous potential of Ethereum has been noticed and recognized, more and more global companies and institutions began to frantically file patent applications, including those for improvements of the bottom-layer technology, as well as many kinds of financial and non-financial applications. In an interview with *Fortune*, a lawyer with the Electronic Frontier Foundation pointed out that blockchain technology is a form of software, and that its patent applications should face a high patent-eligibility standard established by the U.S. Supreme Court's *Alice* case, in which almost all of the software would be deemed an abstract idea and patent ineligible.[9] At the same time, the lawyer in *Alice* also feared that the Patent and Trademark Office might fail to apply the proper patent-eligibility standard and grant poor blockchain patents, so that companies will continuously encounter legal minefields that would slow down the innovation of blockchain technology.[10] Furthermore, regarding blockchain innovation's patent problems, NEWSBTC quoted Vitalik Buterin: "Blockchain software companies may end up being amalgamated into existing software giants, at which point blockchain patents will just become part of the existing patent war."[11] He went on to say, "As is the case with all software patents, in my opinion, their availability will only slow down and harm innovation."[12]

Assuming that blockchain patents may truly slow or even impede innovation, it is important to discern the worldwide status of blockchain patent applications, and whether these patent applications would be granted. This article first introduces the blockchain and its related technologies in Chapter 2, and goes on to conduct a patent search in Chapter 3, finding few granted blockchain patents, but many applications pending. Chapter 4 examines whether the patent applications will be granted, finding that although the U.S. Supreme Court in the 2014 *Alice* case almost declared the death of software and e-commerce method patents, the 2016 Federal Circuit *Enfish* case seems to provide a life for the blockchain patents. Accordingly, this article argues that it is possible for the blockchain patent applications to "survive"

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[8] Florian Idelberger, Guido Governatori, Regis Riveret, & Giovanni Sartor, *Evaluation of Logic-Based Smart Contracts for Blockchain Systems*, INT'L SYMPOSIUM ON RULES AND RULE MARKUP LANGUAGES FOR THE SEMANTIC WEB SPRINGER INT'L PUBL'G at 167 (2016).

[9] John Roberts, *Are Blockchain Patents a Bad Idea?* FORTUNE (Dec. 01, 2016), http://fortune.com/2016/12/01/blockchain-patents.

[10] *Id.*

[11] Gautham, *Increasing Blockchain Patents May Soon Hamper Innovation*, NEWSBTC, http://www.newsbtc.com/2016/12/25/increasing-blockchain-patents-may-soon-hamper-innovation/ (last visited May 29, 2018).

[12] *Id.*

under the *Alice* two-prong test. Blockchain innovation may therefore indeed be "blocked" in the mud of potential patent wars.

Because both Bitcoin and Ethereum blockchains are open source software, there seems to be a considerable contradiction between the purpose of patent protection, and the spirit of open source. Finding the legal solutions for the conflicts between open source software and patent rights becomes an important research topic in the field of intellectual property rights. Chapter 5 of this paper discusses three possible solutions to the conflict: the licensing schemes of industrial standard, the licensing schemes of open source software, and open patent campaigns - pointing out that, at the moment, all three have potential to solve the problem, but there are still many issues to be resolved.

II. INTRODUCTION TO CRYPTOCURRENCIES AND BLOCKCHAINS

A. Bitcoin Blockchain and its Open Source Policy

In late 2008, Satoshi Nakamoto published a paper on bitcoin.org titled "Bitcoin: A Peer-to-Peer Electronic Cash System."[13] This, later referred to as the "Bitcoin Whitepaper" in the Bitcoin community, was the world's first introduction to the term Bitcoin and the concept of decentralized peer-to-peer cryptocurrency.[14] On January 3, 2009, Nakamoto released the first version of blockchain (hereinafter "Bitcoin Blockchain"), Bitcoin V0.1, which was open source C++ code for Windows only.[15] He started running the Bitcoin Blockchain the next day, generated the first block (block #0) and mined the first set of cryptocurrency with a value of 50 BTC (the unit of Bitcoin).[16]

Bitcoin and blockchain are different but related. Bitcoin is currently the most important digital currency that allows online transactions and payments from one user to another without the need for an intermediary financial institution.[17] Bitcoin is referred to as a cryptocurrency because its value is secured by a complicated encryption technology.[18] Blockchain is the bottom-layer technology of Bitcoin. Each of the Bitcoin Blockchain users act as nodes that can connect to one another, and are identified by an address that is the cryptographic hash of a public key.[19] Every node stores the pair of public and private keys generated by the Bitcoin Blockchain system

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[13] Nakamoto, *supra* note 1.

[14] Scott Fargo, *It's Bitcoin's Birthday: Whitepaper Released 8 Years Ago Today*, BITCOIN.COM (Oct. 31, 2016), https://news.bitcoin.com/bitcoin-birthday-whitepaper.

[15] Satoshi Nakamoto, *Bitcoin v0.1 released*, (Jan. 9, 2009), https://archive.is/2012.09.04-100507/http://www.mail-archive.com/cryptography@metzdowd.com/msg10142.html.

[16] *Block 0*, BLOCKEXPLORER, https://blockexplorer.com/block/000000000019d6689c085ae165831e934ff763ae46a2a6c172b3f1b60a8ce26f (last visited May 29, 2018). The information of each block can be found on the website blockexplorer.com, including the timestamp of the generating block.

[17] Nakamoto, *supra* note 1.

[18] Catherine Martin Christopher, *The Bridging Model: Exploring the Roles of Trust and Enforcement in Banking, Bitcoin, and the Blockchain*, 17 NEV. L.J. 139, 143 (2016).

[19] Ingo Weber, Xiwei Xu, R´egis Riveret, Guido Governatori, Alexander Ponomarev, & Jan Mendling, *Untrusted business process monitoring and execution using blockchain*, in INT'L. CONFERENCE ON BUS. PROCESS MGMT. at 9 (2016).

while the user initiates a new node.[20] A user owning Bitcoin may send it to another by digitally signing the public key of the receiver and the hash of the previous transaction.[21]

Blockchain is a decentralized network structure[22] in which any information or transaction is reported to each node on the blockchain. Generally, the applied mechanism of consensus on the blockchain is "proof of work" or "proof of stake."[23] After information and transactions are sent to the nodes, the computers at each node (so-called "miners") compete with one another to calculate a complicated mathematical function (so-called "mining"), and the miner who first finishes the calculation obtains the right to record the information and transactions into a new block that is connected to the previous blocks in sequence.[24] The miner's job is to repeatedly calculate the hash value of a Hash Function with the input data of the transactions and a different nonce until the hash value is less than the target of difficulty set by the Bitcoin Blockchain.[25] The miner who finishes the calculation first also obtains a certain amount of new Bitcoins automatically generated by the blockchain as a reward.[26]

Because each block contains its own ID and the ID of the last block, all of the blocks can be linked one by one without a centralized server, so as to enable people to trace all of the transactions on the blockchain to secure the transaction safety.[27] Furthermore, information may be encrypted by a Hash Function before being directed into the blockchain. As the Hash Function is a one-way function, the hash value generated by the Hash Function and stored in the blockchain cannot be reversed to the original information.[28] Accordingly, the hash value can be used to maintain the confidentiality and prove the identity of the information directed into the blockchain by operating the Hash Function on the information again, and checking whether the same hash value is generated. The transparency, untamperability, and undeniability of the information can thereby be confirmed.[29] Moreover, the timestamp of each block can be used to prove the time that the hash value of the information was directed into the blockchain.[30] For these reasons,

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[20] *See* Nakamoto, *supra* note 1, at 7; Michael Crosby, Nachiappan, Pradan Pattanayak, Sanjeev Verma & Vignesh Kalyanaraman, *Blockchain Technology: Beyond Bitcoin*, 2 APPLIED INNOVATION REV. 9-10 (2016), http://scet.berkeley.edu/wp-content/uploads/AIR-2016-Blockchain.pdf.

[21] Nakamoto, *supra* note 1, at 2.

[22] Jeff Herbert & Alan Litchfield, *A Novel Method for Decentralized Peer-to-Peer Software License Validation Using Cryptocurrency Blockchain Technology*, in THE 38TH AUSTRALIAN COMPUTER SCIENCE CONFERENCE at 27 (2015), http://crpit.com/confpapers/CRPITV159Herbert.pdf.

[23] WILLIAM MOUGAYAR, THE BUSINESS BLOCKCHAIN 25 (2016).

[24] ARVIND NARAYANAN, JOSEPH BONNEAU, EDWARD FELTEN, ANDREW MILLER & STEVEN GOLDFEDER, BITCOIN AND CRYPTOCURRENCY TECHNOLOGIES 45 (2016).

[25] Brad Jacobsen & Fred Pena, *What Every Lawyer Should Know About Bitcoins*, UTAH B.J., Aug. 2014, at 40, 41.

[26] George Walker, *Financial Technology Law—A New Beginning and a New Future*, 50 INT'L LAW. 137, 171 (2017).

[27] Idelberger, Governatori, Riveret, & Sartor, *supra* note 8, at 168.

[28] Jiashu Zhang, Xiaomin Wang & Wenfang Zhang, *One-way hash function construction based on 2D coupled map lattices*, 178 INFO. SCI. 1391, 1392 (2008).

[29] *Id.*

[30] Adán Sánchez de Pedro Crespo & Luis Ivan Cuende García, *Stampery Blockchain Timestamping Architecture*, RESEARCH GATE, www.researchgate.net/profile/Adan_Sanchez_De_Pedro_Crespo/publication/308033741_Stampery_B

blockchain technology can be used as a good "proof of existence" tool for digital documents.[31]

The official website, Bitcoin.org, provides a link for any user to download the "Bitcoin Core" for free.[32] The website also notes that the "Bitcoin Core" is free software driven by the Bitcoin community and released under an MIT license.[33] According to the official website of Open Source Initiative, all copies or substantial portions of each software under the MIT license should show the following copyright notice: "*Permission is hereby granted, free of charge, to any person obtaining a copy of this software and associated documentation files (the "Software"), to deal in the Software without restriction, including without limitation the rights to use, copy, modify, merge, publish, distribute, sublicense, and/or sell copies of the Software, and to permit persons to whom the Software is furnished to do so*."[34] Any blockchain developer may download the "Bitcoin Core" and associated documents for free to use or modify the Bitcoin Blockchain in order to develop and distribute their own applications.

For example, the Learning Initiative and Learning Machine of MIT Media Lab released an open source project on June 8, 2016, building an ecosystem for creating, sharing, and verifying educational credentials based on blockchain technology.[35] The source code of the open source project was released on Github[36] under the MIT license.[37]

B. Ethereum and its Open Source Policy

Because the scripting language of Bitcoin Blockchain is not turing-complete, it has only very limited programming capability. Currently, the application of the Bitcoin Blockchain is limited primarily to the transfer of cryptocurrency. Until Bitcoin is accepted as legal currency by governments around the world, the commercial applications of Bitcoin will remain quite limited.

The smart contract has been a dream for over twenty years to date. Nick Szabo published a short article in 1997 titled "The Idea of Smart Contracts," defining a smart contract as one designed "to embed contracts in all sorts of property that is valuable and controlled by digital means."[38] This dream was finally realized in 2013 by a computer genius only 19 years old, Vitalik Buterin. In 2013, he published a

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lockchain_Timestamping_Architecture_BTA/links/57d7dbcf08ae601b39af5b39.pdf (last visited May 30, 2016).

[31] Tom W. Bell, *Copyrights, Privacy, and the Blockchain*, 42 OHIO N.U. L. REV. 439, 465 (2016).

[32] BITCOIN, https://bitcoin.org/en/download (last visited May 30, 2018).

[33] *Id.*

[34] *The MIT License*, OPEN SOURCE INITIATIVE, https://opensource.org/licenses/mit-license.php (last visited May 30, 2018).

[35] Giulio Prisco, *MIT Media Lab Releases Code for Digital Certificates on the Blockchain*, BITCOIN MAGAZINE, (June 8, 2016), https://bitcoinmagazine.com/articles/mit-media-lab-releases-code-for-digital-certificates-on-the-blockchain-1465404945.

[36] *Blockcerts*, GITHUB, https://github.com/blockchain-certificates (last visited May 30, 2018).

[37] Prisco, *supra* note 35.

[38] Nick Szabo, *The Idea of Smart Contracts*, (1997), http://www.fon.hum.uva.nl/rob/Courses/InformationInSpeech/CDROM/Literature/LOTwinterschool2006/szabo.best.vwh.net/idea.html (last visited May 30, 2018).

whitepaper introducing Ethereum, an alternative peer-to-peer decentralized blockchain (hereinafter the "Ethereum Blockchain").[39] The Ethereum Blockchain created another cryptocurrency called Ether. Unlike the Bitcoin Blockchain, which is turing-incomplete and has only limited scripting capability, the Ethereum Blockchain is turing-complete with a more functional scripting language,[40] allowing users to write and deploy smart contracts and other decentralized applications (Dapp).[41]

Ethereum Blockchain has two kinds of accounts, i.e., external accounts and contract accounts. The external accounts are for general users. When users create an external account, the system asks them to key in a password, after which the Ethereum Blockchain generates a pair of public and private keys for the external account. The external account is represented by an address that is a sequence of numbers generated from the account's public key.[42] There is no concept of account name at the Ethereum Blockchain, and the address representing the external account has nothing to do with the identity of the user. Because this blockchain system does not request users to register using their real name, users are anonymous on the blockchain.[43]

Contract accounts store the smart contracts code. Each contract account is represented by an address generated when the smart contract is deployed into the Ethereum Blockchain. The address of a contract account is derived from some information related to the smart contract, such as the creator's address, the number of transactions, and the nonce (to be explained later).[44]

Smart contracts in Ethereum Blockchain are treated as autonomous scripts. Ethereum has developed two kinds of programing languages for users to write smart contracts, i.e., Solidity (similar to JavaScript) and Serpent (similar to Python).[45] Ethereum also created an Ethereum Virtual Machine (EVM) as the environment for deploying and executing smart contracts in Ethereum Blockchain. Users can write a smart contract by using Solidity or Serpent to transform the clauses of a real contract into a programming code, compile the code down to EVM bytecode, and deploy the bytecode into the Ethereum Blockchain for execution.[46]

Once it is deployed into the blockchain, the smart contract cannot be amended and will self-execute as soon as the conditions of the contract are satisfied.[47] No human operations are needed. Therefore, smart contracts can, to some extent, address real-life problems such as when a contract is subject to the performance of a

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[39] Buterin, *supra* note 7.

[40] Michael Abramowicz, *Cryptocurrency-Based Law*, 58 ARIZ. L. REV. 359, 362 (2016).

[41] Buterin, *supra* note 7.

[42] Ethereum Revision, *Introduction to Smart Contracts*, https://solidity.readthedocs.io/en/develop/introduction-to-smart-contracts.html#a-simple-smart-contract (last visited May 30, 2018).

[43] MELANIE SWAN, BLOCKCHAIN: BLUEPRINT FOR A NEW ECONOMY 36 (2015).

[44] Ethereum Revision *supra* note 42.

[45] Vitalik Buterin, *A Next-generation Smart Contract and Decentralized Application Platform*, WHITE PAPER (2014), https://www.weusecoins.com/assets/pdf/library/Ethereum_white_paper-a_next_generation_smart_contract_and_decentralized_application_platform-vitalik-buterin.pdf.

[46] Idelberger, Governatori, Riveret, & Sartor, *supra* note 8, at 167.

[47] SAMUEL BOURQUE & SARA FUNG LING TSUI, A LAWYER'S INTRODUCTION TO SMART CONTRACTS 4 (2014).

number of intermediaries and can significantly reduce (or even completely eliminate) labor costs, administrative fees, and time costs associated with the intermediaries.[48]

Ethereum provides a command line interface called Geth for running a full Ethereum node.[49] According to an official announcement for Geth on the Ethereum website, the Ethereum Core Protocol is licensed under the GNU Lesser General Public License (hereinafter "the GNU LGPL"), and all fronted client software under the Command Line Interface. Geth is licensed under the GNU General Public License (hereinafter "the GNU GPL").[50]

The GNU GPL, a free and copyleft license for software, is released by the Free Software Foundation.[51] The foundations of the GNU GPL are to ensure the following four types of freedoms for all users of software: (1) the freedom to use the software for any purpose of the user; (2) the freedom to change the software to suit the needs of the user; (3) the freedom to share the software with the neighbors and friends of the user; and (4) the freedom to share the changes made by the user.[52] The current version of GNU GPL is Version 3 (hereinafter "GNU GPLv3"), announced on June 29, 2007.

Under the GNU GPLv3, the source code of each software program should be disclosed so that users can freely access and use it.[53] In order to guarantee users' freedom to utilize all versions of a software program, the GNU GPLv3 explicitly affirms unlimited permission for all users to run, revise, and propagate any copyrightable software licensed under the GNU GPLv3.[54] In order to achieve the goal of free access and sharing of software, GNU GPLv3 does not allow users to use and modify free software released by others, and refuses to allow others to use or propagate their modified version of software. The GNU GPLv3 therefore requests the software user to respect the freedom of other users by passing on to the recipients the same freedom they received.[55]

III. OUTBREAK OF THE BLOCKCHAIN PATENT APPLICATIONS IN THE U.S. AND CHINA

The world's major financial, telecommunication, and cutting-edge financial technology (Fintech) companies and institutions are all trying their best to get in on the ground floor of this emerging and rapidly-developing new technology. Filing patent applications for the R&D results of blockchain technology has become key to early success. In order to understand the current situation of global patent applications for blockchain, it was necessary to conduct a patent search, during

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[48] Riikka Koulu, *Blockchains and Online Dispute Resolution: Smart Contracts as an Alternative to Enforcement*, 13 SCRIPTED 40, 54-55 (2016).

[49] *Geth*, GITHUB, http://github.com/ethereum/go-ethereum/wiki/geth#license (last visited Sept. 16, 2018).

[50] *Id.*

[51] *GNU General Public License*, FREE SOFTWARE FOUND. (June 29, 2007), https://www.gnu.org/licenses/gpl-3.0.en.html.

[52] Brett Smith, *A Quick Guide to GPLv3*, FREE SOFTWARE FOUND. (2007), https://www.gnu.org/licenses/quick-guide-gplv3.html.

[53] FREE SOFTWARE FOUNDATION, *supra* note 51

[54] *Id.*

[55] *Id.*

which the authors found that the number of issued blockchain patents is still low. However, there are a large number of pending patent applications in both the U.S. and China, which this article will examine in the next section.

A. An Overview of the Blockchain Patents

1. Research Method

A patent search was conducted on March 31, 2018, using official U.S. and Chinese websites. The patent search was restricted to patents that had been filed between Jan. 1, 2008, and March 31, 2018, since the "Bitcoin Whitepaper" was published in late 2008. Hence, patents before 2007 are not considered in this article. A patent search in the fields of "title of the invention," "abstract," or "claims" by using "blockchain," "distributed ledger," or "smart contract" as keywords in the bulletin databases of the U.S. and China revealed that the number of issued blockchain patents are still limited: 73 in the U.S., and 10 in China.

2. The Issued Blockchain Patents in the U.S.

The 73 patents approved by the U.S. are not concentrated in the hands of a few companies but belong to 60 different assignees. With the exception of Monticello Enterprises, which has four patents, and Winklevoss IP and IDM Global, having three each. The remaining assignees have only one or two patents each.

This low number shows that blockchain patents in the U.S. are still in the initial stage, and no company has absolutely taken the lead. It is worth noting that three patents are owned by IP holding companies. First, U.S. Pat. 9,338,148 titled "Encryption Decentralized Information and Password Management" is co-owned by the patent licensing firm Verizon Patent and Licensing Inc. and Cellco Partnership, two research and development companies in the Verizon group. Second, U.S. Pat. 9,667,600 titled "Decentralized and distributed secure home subscriber server device" is owned by AT&T Intellectual Property I LP. Third, U.S. Pat. 9,760,574 titled "Managing I/O requests in file systems" is owned by EMC IP Holding Co LLC. Because all of these patents are related to bottom-layer blockchain technology, they may have a significant impact on the blockchain industry in the future.

In terms of the international patent classification (IPC), 73 blockchain patents in the U.S. mainly focus on H04L, G06F, and G06Q; 27 of these are H04L 29/06 (communication control; communication processing characterized by a protocol), 18 are H04L 9/32 (arrangements for secret or secure communication including means for verifying the identity or authority of a user of the system), 18 are G06F 17/30 (information retrieval; database structures therefore), and 11 are G06Q 20/40 (authorization, e.g., identification of payer or payee, verification of customer or shop credentials; review and approval of payers, e.g., check of credit lines or negative lists).

3. The Issued Blockchain Patents in China

There are 10 patents approved by the State Intellectual Property Office, the patent authority of China. Among them, OneConnect Blockchain Technology Co., LTD., has three patents, including: "Safe transaction method and system based on block chain,"[56] "Transaction verification method and system based on block chain,"[57] and "Blockchain cluster processing system and method."[58]

Beijing PeerSafe Technology Co., Ltd. also has three patents, including "Data synchronism method and system,"[59] "Log database system and log database synchronization method,"[60] and "Database write-in method and system based on block chain network."[61]

It is worth noting that Sun Yat-sen University has two patents, including "Blind verifiable cryptographic signature method based on block chain"[62] and "Fair contract signing method based on block chain."[63]

B. Current Status of Blockchain Patent Applications

1. Research Method

A patent search was conducted on March 31, 2018, using the official U.S. and Chinese websites. For the same reason mentioned above, the search was limited to patent applications filed between Jan. 1, 2008, and March 31, 2018.[64] The search found many pending blockchain patent applications that have been published but not yet issued in the U.S. and China: 768 in the U.S. and 1,280 in China.

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[56] Pengfei Y., Yifan L., Yu Z. & Yuxiang H., Method and System for Blockchain-Based Secure Transactions, CN106845960B (2017).

[57] Xiaoxing Y., Yifan L., & Yuxiang H., Verification Method and System for Blockchain-Based Transactions, CN106548330B (2017).

[58] Chenyifan L., Si S., Xiongwen L., & Yuxiang H., System and Method for Blockchain Cluster Processing, CN106685743B (2017).

[59] Feipeng W., Wei C., & Xiaoming L., Data Synchronization Method and System, CN106649632B (2017).

[60] Shuangquan C., Wei C., & Xiaoming L., Log Database System and Synchronization Method, CN106776894B

[61] Shuangquan C., Wei C., & Xiaoming L., Blockchain-Based Database Inputting Method and System, CN106611061B (2017).

[62] Haibo T., Hiejia H., & Liqing F., Block-Based Blind Verifiable Cryptographic Signature Method, CN107040383B (2017).

[63] Haibo T., & Liqing F., Method of Fair Contract Signing Based on Blockchain, CN106504008B (2017).

[64] The patent search was conducted in fields of ("title of the invention" or "abstract" or "claims") by using ("blockchain" or "distributed ledger" or "smart contract") as keywords in the publication databases of the United States and China.

2. The Published Blockchain Patent Applications in the U.S.

In the U.S. as of March 31, 2018, there are 768 blockchain patent applications that have been published but not yet issued. Compared to the results of the U.S. patent search conducted on April 30, 2017 (only eleven months before the current patent search), which showed only 68 blockchain patent applications, the U.S. published 682 patent applications (nearly nine times the 2017 amount) in the field of blockchain technology during eleven months. The number and the growth rate are indeed surprising. Among those 768 Blockchain patent applications, the top ten patent applicants are Bank of America Corp. and International Business Machines Corp. both with 35, MasterCard International Inc. with 28, the Toronto-Dominion Bank with 16, Ripple Luxembourg S.A. with 15, FMR LLC and Raise Marketplace Inc., both with 14.

Bank of America is the second largest bank in the United States measured by assets.[65] Among its 35 published patent applications, nine of them involve payment or data transaction records, eight of them concern data-transfer methods, seven of them involve process authorization, five of them concern systems for tracking and validation of the data on blockchain network, and four of them concern access systems controls or devices for blockchain networks. Sixteen of the 35 patents focus on G06Q 20/40, and 15 patents are in H04L 29/06, indicating Bank of America gave consideration to both fields of fundamental information systems and financial applications in its patent application.

IBM, an American-based multinational technology giant headquartered in Armonk, New York, has 35 published patent applications. Eight of these concern computer program products, seven involve transactional databases, six concern computer-implemented methods, six involve public key of proofing ownership, and six concern securing the blockchain network. This balanced portfolio of 35 patents includes nine G06Q 20/38 patents, eight H04L 9/32 patents, eight H04L 29/06 patents, and eight H04L 29/08 patents.

MasterCard is one of the top giants in the credit card world. Among its 28 published patent applications, nine concern electronic transactions, eight are related to computing devices, eight of them involve verifying account detail in order to avoid fraud, six are related to how blockchain information like hash value could be used, four concern digital signatures for signing blockchain transactions, and three involve mobile devices. The main IPCs of these 28 patent applications are G06Q and H04L, with a focus on G06Q 20/38 and G06Q 20/40. This shows that MasterCard's patent applications are mainly in the fields of financial applications. MasterCard filed a PCT application for each U.S. patent application, indicating that it was seeking a dense patent layout in the global industrial and financial world. The influence of MasterCard's patents on the financial industry should not be underestimated.

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[65] *The Largest Banks in the United States*, RELBANKS https://www.relbanks.com/top-us-banks/assets (last visited May 30, 2018).

3. The Published Blockchain Patents in China

In China as of March 31, 2018, there are 1,342 published patent applications that are not yet issued. The leading applicant is Alibaba Group Holding Ltd. with 56 applications, followed by Beijing Rui Josie Technology Development Co., LTD., with 29, Bubi (Beijing) Network Technology Co., Ltd. with 28, China United Network Communications Corporation Limited with 28, and Jiangsu Tongfudun Science and Technology Co., Ltd. with 26 applications. A breakdown by IPC classes shows the top five subgroups are H04L 29/06 (transmission of digital information characterized by a protocol) with 314, H04L 29/08 （transmission control procedure characterized by a protocol） with 252, H04L 09/32 (arrangements for secret or secure communication including means for verifying the identity or authority of a user of the system) with 227, G06Q 20/38 (payment protocols) with 225, and G06F 17/30 (information retrieval; database structures therefor) with 181.

IV. PATENT ELIGIBILITY OF BLOCKCHAIN

As mentioned earlier, companies such as Bank of America, IBM, and MasterCard have already filed many patent applications related to bottom-layer technologies and financial applications of blockchain, which, if granted, would have a significant impact on the global blockchain industry. At present, the topic of most concern to blockchain academia and industry is whether these patent applications are easily granted.

In this regard, as mentioned above, a lawyer with the Electronic Frontier Foundation mentioned that the blockchain is a form of software, and most or even all software patent applications are only abstract ideas and thus not eligible.[66] It is the opinion of this Article, however, that blockchain technology is not always merely software or computer programs. For example, some patent applications cover the technology to implement a logic gate function or the operating system for blockchain IOT devices, which are not merely abstract ideas. In addition, other bottom-layer technologies and financial/non-financial applications of blockchain are not necessarily only abstract ideas.

This chapter will first examine the insights of the U.S. Supreme Court *Alice* case. Second, this chapter will introduce a key 2016 judgment by the Court of Appeals for the Federal Circuit and analyze whether it would affect PTO (Patent and Trademark Office)'s and courts' determination of the eligibility of blockchain patents.

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[66] Roberts, *supra* note 9.

A. Alice Nearly Declared the Death Penalty for Software and E-Commerce Patents.

1. History of CLS Bank Int'l v. Alice Corp.

The 2014 U.S. Supreme Court case *CLS Bank Int'l v. Alice Corp.* (hereafter "*Alice*") all but declared the death penalty for software and e-business patents.[67]

Alice Corporation Pty. Ltd. (hereinafter "Alice") is an Australian company that owns the following four U.S. patents: U.S. Patent No. 7,149,720, U.S. Patent No. 6,912,510, U.S. Patent No. 5,970,479, and U.S. Patent No. 7,725,375 (collectively the "Patents"). In a cease-and-desist letter, Alice asserted that CLS Bank International (hereinafter "CLS Bank"), which operates a global website to engage in international banking activities such as currency transactions, infringed its Patents. In response to Alice's assertion of patent infringement, CLS Bank filed a suit against Alice on May 24, 2007, in the District of Columbia, seeking a declaratory judgment of patent invalidity, non-infringement, and unenforceability by challenging the subject matter eligibility of the Patents.[68] On August 16, 2007, Alice counter-claimed, alleging that CLS Bank was infringing the Patents.[69]

The Patents are related to computer-based schemes applied to financial settlements and risk management on the Internet, which include software, data processing systems, and computers. In more details, the Patents disclosed a computerized commerce platform for two parties to exchange obligations in which a trusted third entity settles the obligations between the first party and the second party so as to diminish the settlement risk.[70]

By applying the machine-or-transformation test for subject matter eligibility established in *Bilski*, the District Court held that certain claims of the Patents are invalid under 35 U.S.C. § 101.[71] Alice appealed. A panel of the Court of Appeals for the Federal Circuit reversed, noting that a claim should be deemed patent-eligible subject matter unless it is "manifestly evident" that the claim is directed to an abstract idea.[72] The Federal Circuit concluded that all of the claims at issue are not evidently ineligible because they contain the computer-implemented practical applications of a commerce concept in the claim limitations.[73] CLS Bank filed a petition for rehearing en banc, and the Federal Circuit granted.[74]

After adjudication en banc, the Federal Circuit vacated the panel opinion and affirmed the District Court's judgment, holding that all of the claims at issue are not directed to eligible subject matter.[75]

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[67] *See* Jasper L. Tran, *Software Patents: A One-Year Review of Alice v. CLS Bank*, 97 J. PAT. & TRADEMARK OFF. SOC'Y 532, 532 (2015).

[68] CLS Bank Int'l v. Alice Corp., 768 F.Supp.2d 221, 223 (D.D.C., 2011).

[69] *Id.* at 228.

[70] *Id.* at 224.

[71] 768 F.Supp.2d 221, at 221.

[72] CLS Bank Int'l v. Alice Corp., 685 F.3d 1341, 1352 (Fed. Cir. 2012), *vacated*, 484 Fed. Appx. 559 (Fed. Cir. 2012).

[73] *Id.* at 1356-57.

[74] CLS Bank Int'l v. Alice Corp., 484 Fed. Appx. 559 (Fed. Cir. 2012).

[75] CLS Bank Int'l v. Alice Corp., 717 F.3d 1269 (Fed. Cir. 2013).

2. Decision of the U.S. Supreme Court

Alice appealed, and the U.S. Supreme Court granted a petition for *certiorari* on Dec. 6, 2013.[76] After several months, the Court reached a decision on June 18, 2014, holding that all of the claims-in-suit are not patent eligible under 35 U.S.C. § 101 by reason that they are only drawn to an ineligible abstract idea.[77] To reach the conclusion, the Court first started from Section 101 of the Patent Act[78] and emphasized that "law of nature," "natural phenomena," and "abstract idea" are three exceptions to patent-eligible subject matter.[79] Second, the Supreme Court emphasized the two-step test grounded in *Mayo*[80]: The first step is to determine whether the claim-in-suit is directed to an abstract idea, and if so, the second step is to consider the elements of the claim-in-suit both individually and as an ordered combination to determine whether they transform the claim-in-suit into a patent-eligible invention.[81]

For the first step, the Supreme Court found that the patents' concept uses a third party to mitigate settlement risk. The concept of intermediated settlement is a fundamental economic practice, a patent-ineligible abstract idea beyond the scope of 35 U.S.C. § 101.[82] Regarding the second step, the Supreme Court quoted *Mayo* to rule that the elements of a claim should be examined to determine whether they are composed of an "inventive concept" that is adequate to transform an abstract idea into a patent-eligible invention. Regarding the requirement of "inventive concept," the Supreme Court stated that a claim reciting an abstract idea has to contain at least one "additional feature" to ensure that it is more than a patent-drafting attempt to preempt the whole abstract idea.[83] With regard to the issue of whether the introduction of a computer into the claim reciting an abstract idea is qualified as the "inventive concept" or "additional feature," the Supreme Court cited *Mayo* and pointed out that the computer implementation does not provide the "inventive concept" required in *Mayo,* and the mere implementation of an abstract idea by a generic computer to conduct e-commerce fails to transform the method claims into a patent-eligible invention.[84]

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[76] Alice Corp. Pty. Ltd. v. CLS Bank Intern., 134 S.Ct. 734, 735 (2013).

[77] Alice Corp. Pty. Ltd. v. CLS Bank Intern., 134 S.Ct. 2347, 2350-51 (2014).

[78] 35 U.S.C. §101 (2012) ("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.").

[79] 134 S.Ct. 2347, at 2354.

[80] Mayo Collaborative Servs. v. Prometheus Labs., Inc., 132 S.Ct. 1289 (2012).

[81] 134 S.Ct. 2347, at 2355.

[82] *Id.* at 2357 ("In any event, we need not labor to delimit the precise contours of the 'abstract ideas' category in this case. It is enough to recognize that there is no meaningful distinction between the concept of risk hedging in Bilski and the concept of intermediated settlement at issue here. Both are squarely within the realm of "abstract ideas" as we have used that term.").

[83] *Id.* ("A claim that recites an abstract idea must include 'additional features' to ensure 'that the [claim] is more than a drafting effort designed to monopolize the [abstract idea].'").

[84] *Id.* at 2357-58 ("But the computer implementation did not supply the necessary inventive concept; the process could be 'carried out in existing computers long in use.' Ibid. We accordingly 'held that simply implementing a mathematical principle on a physical machine, namely a computer, [i]s not a patentable application of that principle.'").

Regarding the patent eligibility of the method claims, the Supreme Court found that the method claims are only to implement the idea of intermediated settlement into a generic computer; while the claim elements were considered separately, the function operated by the computer at each step is "purely conventional."[85] Accordingly, the Supreme Court concluded that the computer used in the method claims is merely a generic computer because the processes recited by the method claims can neither "improve the functioning of the computer itself" nor "effect an improvement in any other technology or technical field."[86]

Moreover, the Supreme Court also held that the storage medium and system claims are not patent eligible because they only recite some components of the generic computer, such as a communication controller and a data storage unit, which are configured to apply the same abstract idea without joining any substance.[87] The Supreme Court reiterated that the interpretation of §101 should not "depend simply on the draftsman's art."[88] In other words, the determination of patent eligibility should be made on the substance of the claimed invention rather than the skillful way the claim is written.[89]

In conclusion, the Supreme Court held in *Alice* that the mere implementation of an abstract idea by a generic computer to conduct e-commerce does not provide the necessary "inventive concept" and fails to transform a method claim into a patent-eligible invention. Traditionally, it is courts' opinion that as long as the patent applicants are willing to write an e-commerce invention as a system claim, the patent application would be held eligible.[90] However, the Supreme Court in *Alice* also overturned such opinions. According to the Supreme Court's opinion, if the computer used in the system claim of an e-commerce invention is only a generic computer, the system claim is still not patent-eligible. Accordingly, *Alice* all but declared the death penalty for software and e-business patents.

B. The Enfish v. Microsoft Case Brought Some Vitality to Software Patents.

Enfish is the patent owner of U.S. Patent 6,151,604 and U.S. Patent 6,163,775 (hereinafter "the patents-in-suit"), which are directed to an innovative model for a computer database called a "self-referential database." Unlike the traditional "relational model" of a database that puts each entity in a separate table, the "self-referential database" in the patents-in-suit puts all data entities in a single table.[91] Microsoft is a giant in the software industry selling a variety of software products throughout the world, including the software ADO.NET. Enfish sued Microsoft in 2012, alleging that the software ADO.NET developed and sold by Microsoft infringes the patents-in-suit. The district court entered a summary judgment in Microsoft's favor, holding that all claims at issue are directed to a patent-ineligible abstract idea,

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[85] *Id.* at 2359.
[86] *Id.* at 2359-60.
[87] *Id.* at 2360.
[88] *Id.*
[89] *Id.*
[90] Bilski v. Kappos, 561 U.S. 593 (2010) (The United States Supreme Court applied a machine-or-transformation test.).
[91] Enfish, LLC v. Microsoft Corp., 822 F.3d 1327, 1330 (Fed. Cir. 2016).

and thus are invalid under 35 U.S.C. § 101.[92] Enfish appealed, challenging the summary judgment of the district court on patent ineligibility under 35 U.S.C. § 101.[93]

On appeal, the Federal Circuit conducted the two-prong *Alice* analysis, and noted that it is suitable in the first step of the *Alice* analysis to consider whether the claims at issue are directed to an improvement to computer capabilities/functionality rather than merely to an abstract idea.[94] The Federal Circuit found that the claims at issue are directed to a specific improvement to the way a computer stores in memory and retrieves data from memory, which is implemented in the "self-referential database."[95] Furthermore, the Federal Circuit also found that the specification of the patent-in-suit teaches the "self-referential database" which achieves many technological benefits over the traditional database, such as less memory requirement, quicker search times, and more operation flexibility.[96]

In conclusion, the Federal Circuit held that the "self-referential database" recited in the patents-in-suit is a specific sort of data structure invented to improve the way a computer operates, so it is not merely a patent-ineligible abstract idea. Since it is not suffixed to an abstract idea under step one of the *Alice* analysis, the Federal Circuit found that they did not need to conduct the step two of the *Alice* analysis.[97]

According to *Enfish*, an invention that improves the way a computer stores and retrieves data from memory, and that achieves some technological benefits over the traditional database (such as less memory requirement, quicker search times, and more operation flexibility), is held patent eligible under the two-prong *Alice* test.

C. Blockchain Technology Has the Potential to Form a Patent Thicket.

Prof. Carl Shapiro proposed the concept of patent thicket for a paper in 2001.[98] He pointed out that several important industries, especially semiconductors, biotechnology, computer software, and wireless communication have formed a series of patent rights that are numerous and overlapped, such that the companies wishing to commercialize new technologies must seek patent licensing from multiple patent owners at the same time.[99] The paper pointed out that the phenomenon of patent clustering causes the development of any new product in these industries to often inadvertently infringe the patent rights, often creating obstacles to subsequent research and development and hindering technological innovation.[100]

As mentioned, within a short period of eleven months, the number of blockchain patents issued by the U.S. increased from eight to 73, and the number of pending

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[92] *Id.* at 1333-34.
[93] *Id.* at 1334.
[94] *Id.* at 1335-36.
[95] *Id.* at 1336.
[96] *Id.* at 1337.
[97] *Id.* at 1339.
[98] Carl Shapiro, *Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard-Setting* (March 2001), https://ssrn.com/abstract=273550.
[99] *Id.* at 1-2.
[100] *Id.* at 3-4.

published blockchain patent applications rose from 86 to 768. Both the number and growth rate are quite remarkable.

From the Federal Circuit's *Enfish* case, it can be gleaned that if an invention changes the structure of a database to improve the performance of a computer, such as upgrading the computer's function to "write data to memory" and to "retrieve data from memory," the invention can be considered more than an abstract idea, and is therefore patent eligible.[101] This opinion would help software or e-commerce inventions to be considered patent eligible if they have some technical advantages over conventional techniques, such as using less memory, reducing data search time, or having greater operational flexibility.

The *Enfish* case could be a key precedent for the Unites States Patent and Trademark Office, federal district courts, and the Federal Circuit to determine whether blockchain patents or patent applications can be found patent eligible under the two-prong *Alice* test. First, the blockchain itself can be considered a new kind of database:[102] a sort of peer-to-peer distributed database.[103] Relying on the operation of its database features, the blocks in sequence form a complete transaction chain that keeps track of all transaction records and ensures transaction security.[104] The decentralized nature of blockchain largely eliminates the need for intermediaries for all transactions. It not only avoids the risk of tampering or vandalism of the central server but also significantly reduces transaction costs by eliminating administrative and service fees charged by intermediaries.[105] Furthermore, once any information or transaction is recorded on the blockchain, it can no longer be revised or altered, and others cannot tamper with it. The security of the data is thus ensured.[106] In addition, when the hash value of a document is loaded into a blockchain, it is imported into a new block with a time stamp that cannot be overwritten or tampered with, thereby securing the import time of the hash value of a specific document.[107]

These features and qualities of blockchain technology drastically improve the performance of computers and the Internet in "writing data to memory" and "retrieving data from memory," rather than just using a generic computer to execute a computer program. After *Enfish*, any blockchain invention with an eligible subject matter and an inventive concept has an excellent chance of being deemed more than a merely abstract idea and therefore patent eligible. Given the large and growing amount of pending patent applications in the U.S., it is highly possible that blockchain technology will form a patent thicket, the impact of which on the development of blockchain technology should not be underestimated.

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[101] 822 F.3d 1327, at 1336-37.

[102] Marco Iansiti & Karim R. Lakhani, *The Truth About Blockchain*, HARVARD BUS. REV., REPRINT R1701J, at 4 (2017), https://enterprisersproject.com/sites/default/files/the_truth_about_blockchain.pdf.

[103] Michael Crosby, Nachiappan, Pradan Pattanayak, Sanjeev Verma & Vignesh Kalyanaraman, *BlockChain Technology: Beyond Bitcoin*, 2 APPLIED INNOVATION REV., at 7 (2015), https://j2-capital.com/wp-content/uploads/2017/11/AIR-2016-Blockchain.pdf.

[104] Idelberger, Governatori, Riveret, & Sartor, *supra* note 8, at 168.

[105] O'Dair, *supra* note 2, at 6-7.

[106] Drescher, *supra* note 1, at 91.

[107] Crespo & García, *supra* note 30, at 10.

V. CONFLICTS BETWEEN OPEN SOURCE AND BLOCKCHAIN PATENTS AND POSSIBLE SOLUTIONS

A. Conflicts Between Open Source and Blockchain Patents

Most of the original blockchain developers are believers in open source software, and as such, they set the blockchain core programs, development interfaces, and application software as open source, thereby enabling all developers or enthusiasts to use them for free. These original developers never intend to collect licensing fees or royalties from other blockchain developers or users based on the copyright of their original work, and neither have they applied for patents.[108] The reasons why blockchain technology has advanced rapidly and the commercial and non-commercial applications have boomed during the past two years are mainly attributable to the rich soil built up by the pioneering blockchain developers who selflessly contributed the blockchain as open source software.[109]

Ironically, follow-up application developers have already applied for a great deal of patents, making the original blockchain developers worry about whether these patent applications will impede or even jeopardize future innovation of blockchain technology. As an analogy to the opinion in the Federal Circuit *Enfish* case, blockchain technology inventions often involve technical features rather than merely reciting the abstract ideas of common software or e-commerce inventions, and, hence, it is very likely that blockchain inventions will pass the two-step *Alice* test. Although such patent applications are derived from the open source software created by the original developers, they involve further modifications and technical developments (such as enhancing the functionality of the software, promoting the processing speed, providing better information safety, etc.) that will certainly satisfy the utility[110] and novelty[111] requirements during patent examination. When further modifications and technical developments cannot be achieved by persons having ordinary skill in the art, these patent applications may be considered inventive or non-obvious.[112] Therefore, blockchain technology patent applications are likely to be granted. As a consequence, it is highly possible that the important early developments of blockchain pioneers may be dismantled by the massive amount of patent applications filed by the followers.

The conflict between open source software and patents seems to be particularly prominent in the blockchain industry because every single blockchain patent and applications are based on the original developers' free source codes. Had the blockchain source codes not been released by original developers such as Vitalik, patented blockchain technology would not be possible. This article focuses on and

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[108] Vilma Woo, *Vitalik Buterin Demands Court Challenge Against New nChain Patent*, BITCOINIST (Jun 26, 2018), https://bitcoinist.com/vitalik-buterin-challenge-nchain-patent/. For example, the founder of Ethereum, Vitalik Buterin, openly criticized Blockchain patents.

[109] *See* Iuon-Chang Lin & Tzu-Chun Liao, *A Survey of Blockchain Security Issues and Challenges*, 19 INT'L J. OF NETWORK SEC. 653, 653 (2017), https://pdfs.semanticscholar.org/f61e/db500c023c4c4ef665bd7ed2423170773340.pdf.

[110] 35 U.S.C. §101.

[111] 35 U.S.C. §102 (2012).

[112] 35 U.S.C. §103 (2012).

investigates the predicaments the law is likely to encounter when open source code clashes with patents, and possible solutions to such predicaments.

B. Possible Solutions for the Conflicts

This article discusses three possible solutions to the conflict: industry standard licensing schemes, open source software licensing schemes, and open patent campaigns, pointing out that while at this moment all three have an opportunity to solve the problem, there are still many outstanding issues to be resolved.

1. Industry Standard Licensing Schemes

With the advancement of technology and the increased complexity of products, very often the research of novel technology and development of new products are not accomplished by a single company. When a new product or service is jointly provided by different companies, issues regarding the compatibility and interoperability of components from different sources arise. Setting an industrial standard for a particular industry is an effective measure to improve product compatibility and to ensure that products or services from different sources are compatible with and substitutable for one another.

To provide blockchain developers an ideal environment for innovation, and to establish market confidence in the blockchain industry, since 2016 the industry has urged the necessity of establishing an industrial standard.[113] The Australian government is the most progressive in promoting a blockchain technology industrial standard. In April 2016, Standards Australia proposed a new field of technical activity for the International Organization for Standardization (ISO), which intends to develop a blockchain standard to support the development of its technology.[114] According to the proposal, data sovereignty, privacy, and a lack of consensus are the most troublesome issues to policy makers, supervising institutions, and the blockchain industry.[115] However, the proposal does not touch the patent issue, such as how companies that own and implement the patents to the standard should disclose their patent information, and how they license their patent rights, to the players under the industrial standard.

Standards Australia hosted the first International Blockchain Standards Conference on April 2017 on behalf of the International Organization for Standardization ("ISO").[116] Many developed countries including Germany, the United Kingdom, Japan, Russia, France, Singapore, China, and the U.S. sent

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[113] Michael Mainelli, *Which Way for Blockchain Standards in 2017?* COINDESK, (Jan. 3, 2017), https://www.coindesk.com/which-way-for-blockchain-standards-in-2017/.

[114] *Blockchain and Electronic Distributed Ledger Technologies—New Field of Technical Activity*, STANDARDS AUSTRALIA, http://www.standards.org.au/OurOrganisation/Events/Documents/Blockchain%20NFTA%20Information%20Sheet.pdf (last visited May 30, 2018).

[115] *Id.* at 4.

[116] Torrin Marquardt, *Blockchain Standards Initiative*, STANDARDS AUSTRALIA (Dec. 16, 2016), https://www.standards.org.au/news/blockchain-standards-initiative.

representatives to attend this meeting.[117] Subsequently, the ISO included the "Blockchain and Distributed Ledger Technologies (ISO/TC 307)" as one of the standards under development, with ten working groups, including reference architecture, use cases, security and privacy, identity, smart contracts, governance of blockchain and distributed ledger technology, interoperability of blockchain and distributed ledger, foundations, security/privacy/identity, and smart contracts and their applications.[118] Currently, there are 37 members participating in this standard, including Australia, Austria, Brazil, Canada, China, France, German, Japan, South Korea, Malaysia, the United Kingdom, the U.S., among others, with 14 observing members, including the Czech Republic, Hong Kong, Indonesia, Iran, Israel, Singapore, and others.[119] Currently, the ISO focuses on the core technologies of the blockchain, such as governance, compatibility, security, privacy, and identity; the patent issue is not presently taken into consideration.

There is currently no public information indicating whether the ISO will incorporate any patented technologies when formulating the blockchain standard. If some patented technologies are included in the industrial standard in the future, any new products or services developed in accordance with it will inevitably utilize the patented technologies. Accordingly, these patents will become standard-essential patents, which will be infringed by any product complying with the industrial standard.[120] Many standard-setting organizations request the patentees of standard-essential patents not to reject the request for a license, or the entire standard will cease to operate properly.[121] To prevent those engaged in this business from being subjected to the exclusivity of standard-essential patents, standard-setting organizations often set a "Patent Policy" that, in most cases, requires the patentee to provide a free license, or a "fair, reasonable, and non-discriminatory" ("FRAND") license to those following the industrial standard.[122]

The authors believe that the blockchain industrial standard should at least require the players participating in the standard-setting procedure to disclose their patents relevant to the standard so that those companies complying with the industrial standard know the risk of patent infringement. Furthermore, in order to enable the implementation of industrial standards, the blockchain standard shall dictate that the patent owners of standard-essential patents shall not decline any licensing requests. As to the licensing mode the blockchain standard adopts, the authors argue that when considering whether the blockchain industrial standard should adopt a free or FRAND license from the patent owners of the standard

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[117] Varant Meguerditchian, *Roadmap for Blockchain Standards, Report*, at *5, STANDARDS AUSTRALIA, (March 2017), http://www.standards.org.au/OurOrganisation/News/Documents/Roadmap_for_Blockchain_Standards_report.pdf.

[118] *Blockchain and Distributed Ledger Technologies*, INTERNATIONAL ORGANIZATION FOR STANDARDIZATION, https://www.iso.org/committee/6266604/x/catalogue/p/0/u/1/w/0/d/0 (last visited April 6, 2018).

[119] *Participation – Blockchain and Distributed Ledger Technologies*, INTERNATIONAL ORGANIZATION FOR STANDARDIZATION, https://www.iso.org/committee/6266604.html?view=participation (last visited April 6, 2018).

[120] Mark A. Lemley & Carl Shapiro, *A Simple Approach to Setting Reasonable Royalties for Standard-Essential Patents*, 28 BERKELEY TECH. L.J. 1135, 1153 (2013).

[121] *Id.* at 1136-37.

[122] *Id.* at 1137.

essential patents, or other patent licensing modes that are more appropriate, the determination should be made by considering factors such as its technological attributes in the field of blockchain, the progress of the patent thicket, and the status of development in the industry. The blockchain industry—owing its entire development to free open source software—most assuredly faces different patent issues than do other industries, primarily because technological developments in industries other than the information industry (such as DVD technology) are not generally based on open source software created by the original developers. Rather, the patented technologies in those industries are developed from the beginning by research institutions or business participants themselves, rendering it well justifiable that the industrial standard shall not excessively intervene in the enforcement of patent rights. In contrast, no patented blockchain technology would exist without the blockchain source codes released by original developers such as Vitalik.[123] The blockchain "Patent Policy" should therefore at least follow the FRAND license scheme adopted as standard by the telecommunication industry, for example, so that the users of blockchain may more easily access the patented technologies.

2. Licensing Schemes of Open Source Software

As discussed above, the traditional licensing terms of open source software ("OSS") do not address the patent issues arising from downstream users modifying OSS code and then filing a patent application for the resultant technology. For example, the MIT licensing scheme adopted by the Bitcoin Blockchain does not address patent issues.[124]

The Ethereum Blockchain, on the other hand, adopts the licensing scheme of GNU GPL.[125] As discussed above, the "Ethereum core protocol" adopts the "LGPL License" issued by Free Software Foundation, whereas the front-end client software developed by using the command line interface Geth utilizes the "GPL License."[126] Chapter 11 of the third version of GPL License ("GPLv3 License"), named "Patents," addresses the OSS patent issues and sheds some light on the solution for the Ethereum Blockchain patent issues.[127]

Chapter 11 of the GPLv3 License first defines the "contributor," the copyright holder who authorizes use of his/her program under the license.[128] The licensed program is called the "Contributor Version."[129] A contributor's "Essential Patent Claims" are all patent claims owned or controlled by the contributor, whether already acquired or thereafter acquired, that would be infringed in some manner, permitted

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[123] Geth, *supra* note 49.. For example, Geth is the Command Line Interface of Ethereum Blockchain. According to an official announcement for Geth on the Ethereum website, the Ethereum Core Protocol is licensed under the GNU Lesser General Public License, and all fronted client software under the Command Line Interface—Geth is licensed under the GNU General Public License.

[124] OPEN SOURCE INITIATIVE, *supra* note 34.

[125] Geth, *supra* note 49..

[126] Geth, *supra* note 49.

[127] *GNU Operating System*, GNU (June 29, 2007), *https*://www.gnu.org/copyleft/gpl.html

[128] *Id.*

[129] *Id.*

by the GPLv3 License, of making, using, or selling its Contributor Version, but do not include claims that would be infringed only as a consequence of further modification of the Contributor Version.[130]

According to the GPLv3 License, each contributor shall grant a non-exclusive, worldwide, royalty-free patent license for the contributor's "Essential Patent Claims" to any user under this license scheme so that the user can make, use, sell, offer for sale, import, and otherwise run, modify, and propagate the contents of its Contributor Version.[131]

However, if some developers, when making further development to the OSS code, did not write down the programing code, but rather filed a patent application for such further development, the patent application would be novel because it differs from the original OSS code technology. Moreover, the patent application might also be non-obvious in light of such further development, and is accordingly more likely to be granted. In this case, since there is no so-called Contributor Version (because the follow-up developer does not write down the programing code for his/her further development), there are no "Essential Patent Claims." Accordingly, the patent owner (in the present case, who is not a "Contributor") is under no obligation to grant a non-exclusive, worldwide, royalty-free patent license. In this case, if other developers in the OSS community utilize the patented technology, the patent owner can assert his/her patent rights against such developers for patent infringement, thereby obliterating open, liberal, and free licensing framework that OSS has always enjoyed.

Therefore, neither the MIT licensing scheme adopted by the Bitcoin Blockchain, nor the GNU GPL license adopted by the Ethereum Blockchain, can solve the difficult problem of follow-up developers choosing not to create programing code after further development, but instead filing a patent application for the newly developed technology and then asserting their patent rights against other blockchain developers. The fact that the original blockchain developers dedicated the core program and development interface to other developers or enthusiasts as OSS created fertile ground for the growth of blockchain technology. Despite this, the patent thicket arising from the vast amount of patent applications filed by follow-up developers may ultimately impede blockchain development, creating an urgent need to devise an OSS licensing scheme suitable for blockchain technology.

For example, the blockchain industry may press the GNU GPL to issue a fourth version in response to blockchain development. This version would provide that if a developer, when making further development based on the OSS code, chooses not to write down the programing code but rather files a patent application for their work, they are still the "Contributor." Accordingly, the patents owned by such developers represent the contributor's "Essential Patent Claims." These developers still need to provide a non-exclusive, worldwide, royalty-free patent license for the contributor's "Essential Patent Claims" to any user under this licensing scheme.

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[130] *Id.*
[131] *Id.*

3. Open Patent Campaigns

In this article, the term "Open Patent" refers to a public promise made by the patent owner at his/her will that the patent owner will not assert all or part of his/her patent rights against anyone or a specific group. In recent years, some researchers have termed such a promise a "patent pledge"[132] or "patent commons."[133]

IBM was the first advocate for open patent.[134] To promote innovation in the information industry and express its support for the OSS movement, in 2005, IBM published on its official website an announcement titled "IBM Statement of Non-Assertion of Named Patents against OSS," which lists 500 U.S. patents and their corresponding foreign patents owned by IBM.[135] IBM promised that the OSS community may use such patented technologies freely, and that it will under no circumstance claim patent infringement.[136] IBM also declared that the promise not to sue the OSS community is legally binding[137]. Although IBM's open patent movement covers only 500 patents, they include such important technologies as user interface, data storage and management, multifunction operation, data processing application, man-machine interface, image processing technology, Internet management, compression and encryption technology, and e-commerce methods.[138] IBM's declaration fully demonstrates its support for the OSS movement; it is of epoch-making significance in the history of open patent.

In 2013, Google also issued a public declaration titled "Google Open Patent Non-Assertion of Pledge," which promised to open 200 patents to the OSS community and to not sue for patent infringement.[139] The 200 patents released by Google include patents in the U.S., Canada, Europe, Japan, and Taiwan, with technologies from various fields such as encryption, distributed database management, alarm monitoring, data access, and the like.[140] It is worth noting that Google promises to open the 200 patents without term limit (until the patent expiry), and that this pledge is enforceable to Google's successors and assignees.[141]

In 2014, Elon Musk, founder of Tesla Motors, published a statement on Tesla's official website, declaring that in view of the spirit of the open source movement, and to promote the advancement of the technology of electric vehicles, Tesla Motors will not bring lawsuits for patent infringement against anyone who employs Tesla's

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[132] Jorge L. Contreras, *Patent Pledges: Between the Public Domain and Market Exclusivity*, MICH. ST. L. REV. 787 (2015); Jorge L. Contreras, *Patent Pledges*, 47 ARIZ. ST. L.J. 543 (2016).

[133] Wen Wen & Chris Forman, *Economic and Business Dimensions—Do Patent Commons and Standards-setting Organizations Help Navigate Patent Thickets?* 59 COMM. OF THE ACM 42, 43 (2016).

[134] Liza Vertinsky, *The Role of Patent Pledges in the Cloud*, at 5, in PATENT PLEDGES - GLOBAL PERSPECTIVES ON PATENT LAW'S PRIVATE ORDERING FRONTIER, (Jorge L. Contreras & Meredith Jacob, eds.) (2017) https://ssrn.com/abstract=3039551.

[135] IBM, *IBM Statement of Non-Assertion of Named Patents Against OSS*, https://www.ibm.com/ibm/licensing/patents/pledgedpatents.pdf (last visited May 30, 2018).

[136] *Id.*

[137] *Id.*

[138] *Id.*

[139] *Google Open Patent Non-Assertion of Pledge – Patents in the Service of Open Source*, GOOGLE, https://www.google.com/patents/opnpledge/ (last visited May 30, 2018).

[140] *Id.*

[141] *Id.*

patented technologies in good faith.[142] Musk indicated that Tesla initially filed for patent applications fearing that the big automobile manufacturers might copy Tesla's technology and then outcompete Tesla with their strong manufacturing and marketing capability.[143] This worry never materialized, as the big automobile companies appeared to have little interest in developing electric vehicle technology.[144] Musk hoped to invoke the dedication of big automobile companies in the development of electric car technology by opening up Tesla's patents, and believed that the application of open source's philosophy on Tesla Motors' patents would strengthen, rather than weaken, Tesla's status as the leader in electric vehicle technology.[145]

When a novel technology or product requires different components or elements from various suppliers, a mechanism that establishes the interoperability among products shall be formulated so as to prompt the network effect. For industries with an industrial standard, such as the wireless communication industry, the standard-setting organization will host meetings so that members may form consensus and then formulate the industrial standard to be followed by all members. When all members follow the industrial standard to develop new products, that industry's products will certainly be compatible and interoperable with one another. However, for industries without an industrial standard, such as the automobile industry, business participants are challenged to create interoperability for different products that are designed and manufactured by various companies; otherwise, the industry will not further expand. The open patent movement is a measure adopted by business participants in some industries, the intention of which is to establish the interoperability among products so as to create the network effect.[146] When companies like IBM, Google, and Tesla opened their patents to the OSS communities or all business participants in their industry, they created an incentive for other business participants to join in that industry's technological development by adopting the patented technology solutions, reducing the litigation risk, and lowering the implementation cost.[147] The open patent movement not only benefits the development of the industry as a whole, but also directs the whole industry toward the technology and market constructed by the owners of the open patents, thereby establishing the network effect and product interoperability, which is, at the same time, advantageous to the patentees of the open patents.[148]

The academic community has certainly taken note of the threat that patents pose to research and innovation. Some researchers opine that the patent thickets composed of a vast amount of patents with overlapping scopes might impede subsequent research and developments, thus creating a hurdle for technological innovation.[149] Some scholars have pointed out that patent thicketing is harmful to

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[142] Elon Musk, *All Our Patent Are Belong to You*, TESLA MOTORS (June 12, 2014), https://www.tesla.com/blog/all-our-patent-are-belong-you.

[143] *Id.*

[144] *Id.*

[145] *Id.*

[146] Contreras, *supra* note 132, at 788-89.

[147] Wen Wen, Marco Ceccagnoli & Chris Forman, *Opening Up Intellectual Property Strategy: Implications for Open Source Software Entry by Start-Up Firms*, 62 MGMT. SCI. 2668, 2669 (2016).

[148] Contreras, *supra* note 132, at 787, 790.

[149] Shapiro, *supra* note 98, at 1.

technological innovations, especially in the field of biotechnology;[150] therefore, many scholars urge open patent projects in biotech. For instance, Maurer et al. published a paper indicating that patenting is not necessarily the only cure for promoting research and development,[151] instead proposing an open source movement to stimulate the research of new drugs for treating tropical diseases.[152]

The Public Patent Foundation, established by American patent attorney Dan Ravicher, is also highly aware that the abuse of patent rights by patentees may impede technological development; its mission is to challenge the validity of wrongly issued patents, and to counter patent abuses.[153] Critics have also spoken up about the dense patent thickets in the field of nanotechnology that have created a significant hurdle to that field's research and development.[154] This moved them to urge nanotechnology researchers to open their patents as soon as possible in order to promote the development of nanotechnology and maximize social benefit.[155]

Academic research about whether the open patent movement can truly facilitate technological innovation is still in its early stages, with proponents on both sides. On one side, Wen Wen et al. published a paper in 2016 in Management Science titled "Opening Up Intellectual Property Strategy: Implications for Open Source Software Entry by Start-Up Firms," disclosing the result of an empirical study on IBM's open patent movement.[156] The results indicated that the open patent movement initiated by IBM indeed encouraged many startup companies to develop free software products, and promoted the accumulation of innovation in the industry.[157]

Nonetheless, on the other hand, research exists indicating that patents included in a bundle of "open patents" are not always of good quality, and may not cover all the patents necessary for developing new products or follow-up research.[158] Hence, the efficacy of "open patents" in promoting research and development still needs more attention.[159] Another journal paper indicated that after IBM designated those 500 patents as "open patents," the number of forward citation of those patents decreased year after year.[160] This trend may suggest that subsequent research and development based on those patented technologies dropped significantly, and that IBM's open patent movement may have, in fact, hindered the promotion of

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[150] Robin Feldman, *The Open Source Biotechnology Movement: Is It Patent Misuse?* 6 MINN. J.L. SCI. & TECH. 117, 123-124 (2004).

[151] Stephen M Maurer, Arti Rai & Andrej Sali, *Finding Cures for Tropical Diseases: Is Open Source an Answer?* 6 MINN. J.L. SCI. & TECH. 169, 171 (2004).

[152] *Id.*

[153] Pamela Jones, *Interview: Public Patent Foundation's Dan Ravicher* (Dec. 23, 2003), https://lwn.net/Articles/64378.

[154] Joshua M. Pearce, *Open-Source Nanotechnology: Solutions to a Modern Intellectual Property Tragedy*, NANO TODAY (2013), https://www.academia.edu/4394268/Open-Source_Nanotechnology_Solutions_to_a_Modern_Intellectual_Property_Tragedy.

[155] *Id.*

[156] Wen, Ceccagnoli & Forman, *supra* note 147, at 2688-89.

[157] *Id.*

[158] Wen Wen, Marco Ceccagnoli & Chris Forman, *Patent Commons, Thickets, and Open Source Software Entry by Start-Up Firms*, at 1-2, NBER WORKING PAPER NO. W19394 (2013), https://ssrn.com/abstract=2318764 (last visited May 30, 2018).

[159] *Id.*

[160] Shirish Sundaresan, Deepak Jena & Atul Nerkar, *Open(ing) IP: The Effects of Patent Non-Assertion on Innovation*, (November 21, 2017), https://ssrn.com/abstract=3075251.

innovation.[161] This phenomenon is no doubt due to IBM's opening of patents to OSS developers so that the industry no longer has a need to design around the patents and conduct further research and development. The subsequent reduction in research and development will reduce the number of applications for re-invention patents. The citation rate (forward citation) of IBM's 500 patents has thus dropped significantly.

The authors argue that the patent issues involved in the open patent movement are different from the copyright issues involved in OSS. According to copyright law and the OSS framework, the creator of the initial software is automatically entitled to the copyright, and the creator only authorizes the subsequent developers who accept the licensing terms of the OSS to use the creator's work. Should the user or subsequent developer of the OSS violate the terms of the licensing scheme, such as MIT or GNU GPL, the copyright license of the initial open source code would be no longer valid. The subsequent developer who does not obey the licensing scheme is deemed to use the copyrighted software without a valid license, so the copyright owners of the original source code software may enforce their copyright against the subsequent developer for copyright infringement. Accordingly, the OSS movement, on one hand, strongly urges the idea of free software to avoid being bound by copyright, but, on the other hand, employs copyright as the ultimate weapon against those who do not follow the OSS rules.

The world of open patent is a different scenario altogether. Some researchers argue that open patents may design a mechanism that is the same as OSS, which requests that follow-up developers of an open patent maintain the spirit of openness and open the core technology, and any improvement derived from the technology, of open patent; otherwise, the patent owners of open patents may file a patent infringement suit against those who do not follow the rules of open patents.[162] This is not, however, applicable to blockchain technology, because the original developers of the core blockchain technology did not file a single patent application. This situation is not analogous to the case of the OSS movement, in which developers are automatically entitled to the software's copyright once it is completed. The original developers of the core blockchain technology did not file any patent applications, so they do not have any patent rights as the ultimate weapon against those who do not follow the licensing rules. Moreover, even if the original developers of the core blockchain technology had filed for patent applications, the patent rights work only to the manufacturers or vendors, but not to the non-practicing entities that are not involved in the business of manufacture or sale. Therefore, the copyright enforcement mechanism in OSS is not always applicable in the world of open patents.

In view of the foregoing, regarding the patent issues faced by blockchain technology, open patent may be a feasible solution. Promoting the open patent movement in the blockchain field may however encounter more difficulties than in other industries. Open patent has no binding in law but relies on the autonomous action of the patent owners. The blockchain industry, especially the original developers of the core blockchain technology, should provide incentives for the right holders of subsequent patent applications to willingly and spontaneously open their patents.

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[161] *Id.*

[162] Feldman, *supra* note 150, at 135.

VI. CONCLUSION

Finding a legal solution for the conflicts between OSS and patent rights is an important, but little-mentioned research topic in the field of intellectual property rights. The newly-developing blockchain technology is a good example to explore the dilemma and find the solutions.

The blockchain is a rapidly-developing technology with many financial and non-financial applications. The original blockchain developers set the core programs, development interfaces, and application software of the blockchain as OSS, open to all developers for free. They have never thought of collecting royalties by claiming copyright, nor did they apply for patents. However, on the contrary, many follow-up blockchain developers applied the core programs for further developments, and filed a large number of patent applications, causing the original blockchain developers to be concerned about whether these patents will slow down or even endanger the innovation of blockchain technology.

As these patents may truly slow, or even impede innovation, it is important to examine the worldwide status of blockchain patent applications and their likelihood of being granted. While a patent search did not reveal many granted blockchain patents, there are however a great many patent applications. In the U.S. as of March 31, 2018, there are 768 blockchain patent applications that have been published, but not yet issued. Compared to the results of the U.S. patent search conducted on April 30, 2017 (only eleven months before the current patent search), which showed only 68 blockchain patent applications, the U.S. published 682 patent applications (nearly nine times the 2017 amount) in the field of blockchain technology during eleven months. In China as of March 31, 2018, there are 1,342 published patent applications that are not yet issued. The number and the growth-rate are indeed surprising in both countries.

Although the U.S. Supreme Court in the 2014 *Alice* case almost declared the death of the software and e-commerce method patents, the *Enfish* case by the Federal Circuit in 2016 seems to breathe new life into blockchain patents. According to *Enfish*, an invention that improves the performance of a computer by changing the structure of a database, such as enhancing the performance of the computer "to write data into memory" and "to retrieve data from memory," can be more than an abstract idea, and is therefore patent eligible. The blockchain itself can be seen as a new, peer-to-peer, decentralized database that dramatically enhances the performance of computers and the Internet by efficiently writing into and retrieving data from memory instead of using "generic computers" to execute the programs. Accordingly, the authors argue that it is possible for the blockchain patent applications to "survive" under the *Alice* two-prong test. Therefore, blockchain innovation may indeed be "blocked" by potential patent wars. Finding legal solutions to the conflicts between OSS and patent rights becomes an important research topic in the field of intellectual property rights.

This article covered three possible solutions to the conflict: the licensing schemes of industrial standard, the licensing schemes of OSS, and open patent campaigns, pointing out that at this moment, all three have an opportunity to solve the problem, but there are still many issues to be resolved. In terms of the licensing schemes of industrial standard, this article considers that the blockchain industrial standard should require the patentees involved in standard-setting to disclose their patents,

and require the owners of the standard-essential patents not to refuse patent licensing. As to what kind of licensing scheme should be adopted for the blockchain standard, this article compares blockchain with other industries by examining the technical attributes of blockchain, the process of patent thicketing, and the development of the industry, suggesting that the "Patent Policy" of the blockchain standard should at least follow the FRAND license scheme adopted as standard by such industries as telecommunications. As a result, the users of blockchain may access patented technologies more conveniently, reflecting the special characteristics of blockchain technology.

In terms of the licensing schemes of OSS, this article pointed out that the MIT license for the Bitcoin Blockchain, and the GNU GPL license for the Ethereum Blockchain, cannot solve the problem of follow-up developers failing to draft a software code, but applying for patents for the results of follow-up developments. This article compares the similarities and differences of other OSS, and studies the original philosophical spirit, technological development, and industrial development of blockchains, suggesting a suitable licensing scheme of OSS for blockchain technology.

Open patent campaigns could certainly be a possible solution to the patent problems faced by the blockchain technology. Promoting the open patent movement in the area of blockchain obviously faces more challenges than in other industries, however, relying as they do on the spontaneous action of the patentee. The blockchain industry, especially the original developers of its core technology, should provide incentives for the right holders of subsequent patent applications to willingly and spontaneously open their patents.