Distributed Stock Ledgers and Delaware Law

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Effective August 1, 2017, the Delaware General Corporation Law (the “DGCL”) now authorizes Delaware corporations to use blockchain technology to maintain stock ledgers and communicate with stockholders. Consistent with the DGCL’s status as an enabling act that facilitates private ordering, the blockchain amendments are permissive. In the near term, they create a foundation for a technology ecosystem by removing any uncertainty about the validity of shares that have been issued or are maintained using blockchain technology. Over a longer time horizon, the amendments foreshadow a more flexible, dynamic, and digital future in which distributed ledger technology and smart contracts play major roles.

I. WHAT IS BLOCKCHAIN?

Blockchain technology is a means of recording transactions involving assets without the need for a central intermediary to track ownership of those assets in an authoritative ledger. Blockchain technology replaces the central intermediary with a distributed ledger maintained by multiple participants and secured by advanced cryptography. Blockchain technology thus enables parties to transact remotely, securely, and directly, without a recordkeeping middleman.

Credit for inventing blockchain technology goes to a still-unidentified person operating under the alias “Satoshi Nakamoto.” In October 2008, one month after Lehman Brothers’ collapse, Nakamoto released a nine-page white paper that proposed a method for peer-to-peer currency transfer without the use of a central intermediary.1 In January 2009, Nakamoto released software for the bitcoin cryptocurrency, which used the techniques outlined in his white paper, and created the first bitcoins.2 As of January 11, 2018, bitcoin has a market capitalization of approximately $240 billion.3

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2. See Andrea Peterson, Hal Finney Received the First Bitcoin Transaction. Here’s How He Describes It, WASH. POST (Jan. 3, 2014), https://www.washingtonpost.com/news/the-switch/wp/2014/01/03/hal-finney-received-the-first-bitcoin-transaction-heres-how-he-describes-it/?utm_term=.0a06048a5e57.
The problem Nakamoto identified in his white paper was that “commerce on
the Internet has come to rely almost exclusively on financial institutions serving as
trusted third parties to process electronic payments.”4 While this method worked
“well enough for most transactions,”5 it also generated costs. Trusted third parties
charged fees for their services and could dictate how and when transactions took
place. The use of intermediaries thus had the effect of “limiting the minimum prac-
tical transaction size and cutting off the possibility for small casual transactions.”6

Equally important, reliance on trusted intermediaries did not eliminate fraud, or
what Nakamoto described as “the loss of ability to make non-reversible payments
for non-reversible services.”7 In lay terms, this problem is the ability of a buyer to
represent that he has funds to pay for a transaction, induce a seller to provide goods
or services based on that representation, and then not actually have the funds. If the
seller can recover its goods or services, then the only harm to the seller is transac-
tion costs. But if the seller cannot recover, then the seller suffers harm in the full
amount of the goods or services lost. If market participants fear this outcome,
then they must incur additional costs to protect themselves, or transaction costs
may become so large that they destroy the economic benefits of the transaction.

Nakamoto’s white paper focused in particular on the “double-spending prob-
lem,” in which a buyer fraudulently (or mistakenly) uses the same funds for
two transactions.8 The trusted intermediary can limit this problem by monitoring
transactions in real time to block double-spending transactions as they occur, or it
can remedy the problem after the fact by reversing a fraudulent or erroneous trans-
action. But providing those precautions and services raise the trusted intermedi-
ary’s costs, which in turn raise costs for market participants. There is also the prob-
lem of effort: market participants must trust the intermediary to do its job correctly
or expend resources pursuing a remedy independently. In short, the intermediary
creates economic friction.

Nakamoto explained that “[w]hat is needed is an electronic payment system
based on cryptographic proof instead of trust, allowing any two willing parties
to transact directly with each other without the need for a trusted third party.”9
The resulting system incorporates two principal features: (i) a distributed ledger,
with every participant in the network maintaining a copy of the ledger that doc-
uments ownership of an asset, and (ii) a method for accurately updating that led-
ger by consensus.

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4. NAKAMOTO, supra note 1, at 1.
5. Id.
6. Id.
7. Id.
8. Id.
9. Id.
A. THE DISTRIBUTED LEDGER

At the core of blockchain technology is the distributed ledger. Under this system, the centralized, authoritative ledger maintained by the trusted intermediary is replaced by multiple identical copies of a ledger maintained through the collective action of a network of participants. Each computer in the network, called a node, keeps its own copy of the ledger. Using a peer-to-peer platform, each copy of the ledger updates whenever new transactions occur.

To understand the revolutionary nature of this change, consider perhaps the quintessential example of a centralized intermediary: the Board of Governors of the United States Federal Reserve System (the “Federal Reserve”).\(^{10}\) Using a centralized ledger, the Federal Reserve facilitates interbank transfers, which in turn are necessary for party-to-party transfers.\(^{11}\) In a simplified scenario, Delaware Corporation, which banks with Delaware Bank, wants to pay $1,000 to New York Corporation, which banks with New York Bank. Both Delaware Bank and New York Bank are members of and maintain accounts with the Federal Reserve. To send a payment of $1,000 to New York Corporation, Delaware Corporation initiates the transaction with Delaware Bank. Delaware Bank debits the account of Delaware Corporation by $1,000. At the same time, Delaware Bank instructs the Federal Reserve to debit Delaware Bank’s institutional account by $1,000 and to credit New York Bank’s institutional account with a corresponding $1,000. New York Bank completes the transaction by crediting the account of New York Corporation with $1,000.\(^{12}\)

As this example shows, moving money between two end users requires coordination among three independently maintained ledgers. The Federal Reserve maintains the central ledger for its member banks and enables them to move money by adjusting their account balances on its central ledger. Each member bank performs a similar function for its customers. In each case, the bank determines the amount of money the payor has, which for purposes of the immediate transaction, is authoritative. A customer who wishes to challenge the bank’s determination must invest time and resources in raising the matter with the bank. If the bank declines to reconsider its determination, then the customer must resort to external channels, such as litigation.

In developing bitcoin, Nakamoto was responding to the Internet’s dependence on centralized payment networks for processing transactions. The assets used in the centralized payment networks were official currencies, such as dollars, and the records of their ownership were maintained in various payment networks on multiple, centralized ledgers. Nakamoto proposed to create a new class of as-


sets, called bitcoins, and to maintain the records of their ownership using a single, distributed ledger.13

In a system that uses distributed-ledger technology, multiple participants in the network simultaneously maintain copies of the same ledger, then cooperate to update the ledger whenever a transaction occurs.14 The ledger itself is a database of all recorded transactions related to the ownership of the asset tracked by the ledger.15

The ledger is distributed because every participant in the network has a copy. Every participant can see the current state of ownership for all assets on the ledger, and every participant has a record of every transaction that has ever occurred on the ledger.16 If the Federal Reserve were replaced with distributed-ledger technology, then its member banks would be the network participants. Each bank would possess and maintain a copy of the same ledger and every bank could see every transaction in U.S. dollars that had occurred between banks on the ledger.17

The problem Nakamoto identified is broad; it is not limited to official currencies and centralized payment systems. It exists whenever a system uses a centralized ledger to track ownership of an asset. It could be the centralized record of real estate transfers maintained in a county land use office. It could be the centralized record of automobile title ownership maintained by a state’s division of motor vehicles. Or it could be a centralized record of Uniform Commercial Code (“UCC”) filings.

What makes the blockchain solution that Nakamoto identified extraordinary is that it is a comprehensive solution to this broad problem. The asset that is tracked through a distributed ledger by a coin need not represent a single unit of value, as with currency. The coin can represent an ownership claim to an underlying asset, be it real estate, a vehicle, a lien, or a share of stock. Under this system, ownership of the coin carries ownership rights embodied in the asset it represents, and a transfer of the coin transfers those rights. A blockchain system can theoretically track virtually any type of property and replace virtually any type of centralized network.

15. Id. at 10–11.
16. See id. at 28. Participants can transact with one another off the ledger, and then propose an omnibus update to the ledger. These “off-chain” transactions can provide transactors an additional degree of anonymity and may enable cheaper and more efficient transactions. See generally Daniel Cawrey, Are Off-Block Chain Transactions Bad for Bitcoin?, COINDESK (May 14, 2014), https://www.coindesk.com/block-chain-transactions-bad-bitcoin/ (explaining that off-chain transactions may be an important means to scale bitcoin as transaction fees on the network increase).
17. Note that replacing the Federal Reserve with distributed ledger technology would not eliminate the banks. Each bank would become a node in the network and maintain a ledger for its customers. For the technology to take the next step and eliminate the banks’ role in the movement of money, each individual customer would have to become a node on the network and maintain a copy of the ledger. The Bitcoin protocol achieves this endpoint for bitcoins.
B. RESOLUTION BY CONSENSUS

A second key feature of blockchain technology is the method used to update the ledger and maintain its integrity. An obvious problem with having multiple copies of the same ledger is the need to make sure all versions of the ledger agree, both before and after transactions take place. In a centralized system, the central intermediary maintains the ledger and rules that ledger by fiat. The ledger at the Federal Reserve, for example, is maintained and updated by the Federal Reserve, which has sole authority to update its ledger and therefore ultimate authority over the legitimacy of a transaction, challengeable only through channels outside the ledger.\(^\text{18}\) A distributed ledger does not have a central decision maker. Instead, the nodes in the network apply decision rules to reach agreement through a process called consensus.\(^\text{19}\) Different distributed ledger technologies use different consensus mechanisms, but the basic concepts are the same.

The need to update the ledger emerges when two end users propose a transaction. The result of the proposed transaction will be to transfer record ownership of an asset.\(^\text{20}\) Once proposed, other participants in the network assess whether the proposed transaction is authentic.\(^\text{21}\) The ultimate determination is made by a decision rule. A simple example might be that a transaction is valid if it matches up with the ownership of the asset as shown on the ledger as kept by a majority of the nodes in the network. Once validated, the proposed transaction is added to the ledger and treated as authentic.

The problem with a simple decision rule like approval by a majority of the nodes is that it could expose the network to attack. If an attacker gained control of a majority of the nodes, it could use its control to approve fraudulent transactions and allocate to itself resources. There are a variety of more sophisticated decision rules that can be used to address this problem. Under Bitcoin’s approach, nodes must expend external resources to vote, making any attack expensive.\(^\text{22}\) Another response is to raise the threshold from a majority to a supermajority, such as a requirement that 80 percent of the nodes agree. Another response is to use weighted voting, sometimes called proof-of-stake, in which the necessary threshold depends not just on the number of nodes but the assets held by the nodes.\(^\text{23}\) The additional principle in play here is that nodes with a greater stake should be better protected and have a greater interest in ensuring that transactions are accurate because those nodes have a vested interest in the protocol’s success, although this approach also creates the possibility of an inside

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\(^{18}\) See Mills et al., supra note 13, at 9.

\(^{19}\) See id. at 13.

\(^{20}\) See Rosner & Kang, supra note 12, at 654.


Yet another solution involves a permissioned ledger in which users trust the nodes for reasons outside the protocol, perhaps because the user knows all of the nodes in the network or the user can select the nodes that evaluate its transaction. A particular network can incorporate several of these features at once, for example by having a supermajority voting threshold based on proof-of-stake, or requiring approval by a supermajority of trusted nodes.

Bitcoin deploys an innovative solution called “proof of work.” Under this mechanism, a network participant must first perform the work necessary to assemble a series of proposed transactions into a group. Each group of proposed transactions is called a block, giving rise to the “block” in “blockchain.” Each block is linked mathematically to the block posted immediately before it in time, giving rise to the term “chain” in “blockchain.” Network participants who add blocks to the ledger are called “miners,” and they receive a reward of newly minted bitcoins and transaction fees to compensate them for the work necessary to assemble and validate a new block.

In simplified terms, when a bitcoin user enters an instruction to transfer bitcoins to another user, the instruction is broadcast to the network as a proposed transaction. Miners evaluate whether the bitcoin user owns the bitcoins it wants to transfer by attempting a complex mathematical problem. The solution depends on the data in the proposed transaction and the history of transactions existing on the ledger. A miner can only find the correct solution if the history of recorded transactions shows the user has the bitcoins it proposes to transfer.

The solution to the mathematical problem is time-consuming and costly to generate, but easy for other nodes to verify. Once a miner finds the solution, it publishes the block to the network. If a majority of the other participants verify the solution, then the block is added to the ledger, and the ledger is updated. The proposed transaction has now been validated and is part of the blockchain. If an instruction is propagated to the network for a future transaction involving the same bitcoins, then the nodes will compare the instruction against the updated blockchain, which now includes a record of the transfer of ownership.

This proof-of-work approach has at least two significant benefits. One is that by requiring the expenditure of resources to validate transactions and add them to the blockchain, the system reduces the likelihood of a malicious attack. Any attacker who wishes to gain sufficient mining nodes to control the network must expend an increasing amount of resources to achieve that result. To take full
control of the network would require a lot of money, and if third parties discovered the attack, any accumulated bitcoins would diminish in value. So the system uses economic incentives to protect the integrity of the protocol.

A second benefit of the proof-of-work approach is that the task of assembling multiple transactions into blocks and then chaining transactions together makes it effectively impossible to alter previously validated transactions in the blockchain, because any party that wanted to change a past transaction would have to modify all of the following blocks. The resources required to change a past transaction increase exponentially as each block is added to the chain, quickly becoming cost-prohibitive.

The consensus-based, peer-to-peer methodology thus makes the blockchain network reliable and secure. There is no single server that can be taken over on which the entire network depends. Even if part of the network is disrupted, the remaining nodes can continue to function, and information is updated only if validated according to the decision rules established by the network.

II. BLOCKCHAIN AND THE STOCK LEDGER

One form of ledger that traditionally has been maintained centrally is a stock ledger that identifies who owns how many shares of a particular class or series of stock. Before the recent blockchain amendments, the DGCL operated based on “a simplified model of a Delaware corporation [in which] the corporate secretary maintains a document called the stock ledger.” Under this simplified model, the stock ledger identifies all of the legally relevant transactions in the corporation’s shares, including the date when any person acquires shares and the number of shares acquired, and the date when any person transfers shares and the number of shares sold. If a holder transfers shares without notifying the corporation, the corporation is not required to discover that fact, nor need the corporation voluntarily treat the new holder as the legal owner. The corporation can rely on its records until a stockholder takes proper steps to transfer title [on the corporation’s records].

Indeed, under this system, a paper stock certificate is not actually a share of stock: it is only evidence of ownership of a share of stock, just like a coin on a blockchain may only embody the ownership rights of an asset. The centralized ledger controls.

31. See Nakamoto, supra note 1, at 3.
33. Id.
34. See Del. Code Ann. tit. 8, § 158 (2016) (“The shares of a corporation shall be represented by certificates, provided that the board of directors of the corporation may provide by resolution or resolutions that some or all of any or all classes or series of its stock shall be uncertificated shares.”); Testa v. Jarvis, C.A. No. 12,847, 1994 WL 30517, at *6 (Del. Ch. Jan. 12, 1994) (Allen, C.) (noting that “possession of a certificate does not itself constitute ownership of shares”); Haskell v. Middle States Petroleum Corp., 165 A. 562, 563 (Del. Ch. 1933) (“A] person may be the legal owner of stock even though he has received no certificate; therefore, the certificate is only evidence of ownership.”); Smith v. Universal Serv. Motors Co., 147 A. 247, 248 (Del. Ch. 1929) (“The status of stockholder in a corporation is not dependent on the issuance to him of a certificate of stock. The certif-
By the turn of the current millennium, the simplified model no longer reflected reality. Most public corporations had outsourced control over their stock ledgers to their transfer agent. Moreover, the federal response to a paperwork crisis on Wall Street during the late 1960s and early 1970s resulted in a further outsourcing of the stock ledger to the Depository Trust Company (“DTC”). To solve the paperwork crisis, the Securities and Exchange Commission (“SEC”) encouraged brokerages and banks to create depositories and deposit their shares centrally with the depositories in the form of jumbo certificates, often representing tens or hundreds of thousands of shares.\textsuperscript{35} DTC emerged as the only domestic depository. DTC’s nominee, Cede & Company (“Cede”), became the largest stockholder of record in most public companies.

DTC is the ultimate central intermediary. Over 800 custodial banks and brokers are participating members of DTC and maintain accounts with that institution. Over 75 percent of the shares of publicly traded companies are held by DTC.\textsuperscript{36} None of the shares are issued in the names of DTC’s participants. All are issued in the name of Cede. Using an electronic book-entry system, DTC tracks the number of shares of stock that each participant holds.

For a publicly traded Delaware corporation, the federal policy of share immobilization layered an additional central intermediary between the corporation’s stock ledger, itself a centralized ledger, and the banks and brokers that hold shares on behalf of customers, who are themselves central intermediaries. In other words, the current ownership model has resulted in three stacked levels of central intermediation. Consider Delaware Corp., a Nasdaq listed Delaware corporation. Kristie owns one share in Delaware Corp. through his broker, Broker LLC. Broker LLC is a member of DTC, who holds a jumbo certificate representing all of Delaware Corp.’s issued and outstanding stock. Under this construct, Delaware Corp. is the record holder for Delaware law purposes, which interacts exclusively with Broker Corp. on behalf of the beneficial owner of the security, Kristie.

The depository system solved the paperwork crisis and facilitated trading, but it complicated many other aspects of corporate law. In contrast to the depository system, state corporate law operates on the assumption that the record holder is the ultimate end user, not an intermediary. Voting rights are bestowed on record holders, not beneficial holders.\textsuperscript{37} Appraisal rights similarly are bestowed on record holders is only an evidence of ownership—a muniment of title.”); Mau v. Mont. Pac. Oil Co., 141 A. 828, 831 (Del. Ch. 1928) (“Possession of a certificate is not essential to the ownership of stock.”); Baker v. Bankers’ Mortg. Co., 135 A. 486, 488 (Del. Ch. 1926) (Wolcott, C.) (“Certificates of stock are themselves only evidence of shares. They are not the shares.”), aff’d sub nom. Sohland v. Baker, 141 A. 277 (Del. 1927).


holders, not beneficial holders. To exercise state-law rights, beneficial holders must become record holders (which makes trading more difficult) or ask the record holder to exercise the rights on the beneficial owner’s behalf (which creates opportunities for error). Extensive litigation has arisen over these issues.

III. THE BLOCKCHAIN AMENDMENTS

In May 2016, Delaware’s then-Governor Jack Markell announced the Delaware Blockchain Initiative. One goal of the initiative was to facilitate corporate recordkeeping by limiting or eliminating unnecessary paperwork. The blockchain amendments responded directly to this goal.

A. SECTION 219

The blockchain amendments start with changes to section 219 of the DGCL, which governs the preparation of a list of stockholders for purposes of voting at meetings. Before the amendments, section 219(a) stated:

The officer who has charge of the stock ledger of a corporation shall prepare and make, at least 10 days before every meeting of stockholders, a complete list of the stockholders entitled to vote at the meeting; provided, however, if the record date for determining the stockholders entitled to vote is less than 10 days before the meeting date, the list shall reflect the stockholders entitled to vote as of the tenth day before the meeting date, arranged in alphabetical order, and showing the address of each stockholder and the number of shares registered in the name of each stockholder.

By referring to an “officer who has charge of the stock ledger,” the old version of section 219(a) manifested the DGCL’s traditional reliance on the simplified model of a Delaware corporation, in which a human, typically the corporate secretary, maintained a set of records comprising a stock ledger. But the old version of section 219 did not provide any guidance on what records comprised it, other than to imply that the stock ledger needed to contain, at a minimum, the information necessary to create the list of stockholders contemplated by section 219(a).

The blockchain amendments make an important change to section 219(a) by eliminating the reference to an “officer who has charge of the stock ledger.” Taken literally, this language could have been read to require an officer to maintain the ledger, meaning that the corporation could not delegate or outsource...
this function. Such a limitation would have conflicted with the widespread practice of outsourcing this function to a transfer agent. It also could have limited the ability of a corporation to use distributed ledger technology. The blockchain amendments eliminate any implications along these lines by revising section 219(a). The new language states simply: “The corporation shall prepare, at least 10 days before every meeting of stockholders, a complete list of the stockholder entitled to vote at the meeting.”

A second important change to section 219 is to add a new statutory definition of “stock ledger.” Section 219(c) now states:

For purposes of this chapter, “stock ledger” means 1 or more records administered by or on behalf of the corporation in which the names of all of the corporation’s stockholders of record, the address and number of shares registered in the name of each such stockholder, and all issuances and transfers of stock of the corporation are recorded in accordance with § 224 of this title.

The new definition makes clear that a stock ledger can be outsourced (or at least does not need to be maintained in-house). Instead of an “officer” having to maintain the “stock ledger,” the “stock ledger” can be “administered . . . on behalf of the corporation.” It also makes clear what the ledger must contain. The new definition does not provide a definition of who is a “stockholder of record,” thereby leaving open the important question of whether DTC participants who appear on the Cede breakdown are “stockholders of record” for purposes of Delaware law, as they are for purposes of federal law.

Together, the changes to section 219 make clear that a corporation has the power to delegate the administration of its stock ledger to a third-party service provider, such as a transfer agent, or to a network of participants, such as its stockholders. The amendments to section 219 do not go so far as to authorize the use of blockchain technology to track share ownership without some involvement by the corporation. The statement that the stock ledger is a document administered “by or on behalf of the corporation” implies that the corporation must remain involved in some capacity.

B. SECTION 224

The blockchain amendments next revised section 224, which governs the form of records of stock ownership. Before the amendments, section 224 provided as follows:

44. Id. § 219(c).
Any records maintained by a corporation in the regular course of its business, including its stock ledger, books of account, and minute books, may be kept on, or by means of, or be in the form of, any information storage device or method, provided that the records so kept can be converted into clearly legible paper form within a reasonable time. Any corporation shall so convert any records so kept upon the request of any person entitled to inspect such records pursuant to any provision of this chapter. When records are kept in such manner, a clearly legible paper form produced from or by means of the information storage device or method shall be admissible in evidence, and accepted for all other purposes, to the same extent as an original paper record of the same information would have been, provided the paper form accurately portrays the record.  

After the amendments, section 224 no longer implies that the corporation must maintain the records. Instead, it states that records may be “administered by or on behalf of the corporation.” It also explicitly authorizes blockchain-based record keeping. The amended statute provides:

Any records administered by or on behalf of the corporation in the regular course of its business, including its stock ledger . . . may be kept on, or by means of, or be in the form of, any information storage device, method, or one or more electronic networks or databases (including one or more distributed electronic networks or databases) . . . .

A blockchain-based system is a “distributed electronic network.”

The new section 224 also introduces minimum requirements for the system that the corporation uses to maintain its stock ledger. The system must be sufficient “to prepare the list of stockholders specified in §§ 219 and 220 of this title,” which require that the corporation be able to produce readily a list of its stockholders. For purposes of section 219, the corporation must be able to produce a list of the stockholders entitled to vote at a meeting of stockholders. For purposes of section 220, the corporation must be able to produce a list of the corporation’s stockholders for inspection by a stockholder with a proper purpose.

The new section 224 next requires that the system be able to “record the information specified in §§ 156, 159, 217(a) and 218” of the DGCL. Section 156 authorizes a corporation to issue partly paid shares that are subject to call for the remainder of the consideration owed. It requires, however, that any certificate issued for partly paid shares reflect the total amount of consideration owed and the amount paid, and that the records of the corporation reflect this information for uncertificated shares. Section 159 requires that the corporation be able to track transfers of shares made for purposes of collateral security or transfers not involving an absolute transfer of title. Section 217(a) requires that a corporation be able to maintain records reflecting the allocation of voting rights in pledged shares and the allocation of voting rights in shares owned by multiple

49. Id. (emphasis added).
50. Id. § 156.
51. Id. § 159.
persons directly or indirectly in various capacities.\textsuperscript{52} Section 218 requires that a corporation be able to maintain records of shares that have been deposited in a voting trust.\textsuperscript{53} A blockchain-powered stock ledger must be able to track the same categories of information.

Finally, the new section 224 requires that the system must be able to “record transfers of stock as governed by Article 8 of subtitle I of Title 6,” which is a reference to Delaware’s version of Article 8 of the UCC. At present, this obligation means that a corporation with certificated shares cannot implement a distributed stock ledger, because Article 8 specifies procedures for transferring certificated shares that are inconsistent with the use of distributed ledger technology.\textsuperscript{54} A corporation with certificated shares thus must convert to uncertificated shares before it can deploy blockchain technology.\textsuperscript{55}

C. SECTION 232

The blockchain amendments also make changes to section 232 of the DGCL, which authorizes notice by electronic transmission. Delaware previously adopted section 232 in 2000 to establish processes by which a corporation may give notice to its stockholders through electronic transmission. To accommodate the sending of notices using blockchain technology, the definition of “electronic transmission” now includes

any form of communication, not directly involving the physical transmission of paper, including the use of, or participation in, 1 or more electronic networks or databases (including 1 or more distributed electronic networks or databases), that creates a record that may be retained, retrieved and reviewed by a recipient thereof, and that may be directly reproduced in paper form by such a recipient through an automated process.\textsuperscript{56}

IV. NEAR-TERM IMPLICATIONS

The purpose of the blockchain amendments was to ensure that Delaware corporations can use blockchain technology to maintain stock ledgers and communicate with stockholders. The blockchain amendments have fulfilled their purpose by establishing that the use of blockchain technology will invalidate or otherwise compromise the validity of otherwise validly issued shares or DGCL-compliant communications.
Consistent with the DGCL’s historic role as an enabling statute that facilitates private ordering, the door is now open to corporations, their advisors, and entrepreneurs to make use of the authorization. The most likely near-term implications are for private companies, particularly venture-backed companies with complex capital structures. One reason blockchain technology will be attractive to these companies is because of its ability to facilitate smart contracts.

A smart contract is a set of coded instructions that execute automatically, without human involvement, when particular conditions are met.57 “The fully automated nature of execution provides for self-enforcing ‘automated trustworthiness’ with no counterparty risk of non-performance.”58

A simple example of a real-word transaction that happens without direct human involvement is the purchase of a product from a vending machine. A user puts in money, punches in a code to select an item, and the machine distributes it. A human intermediary is not required for the transaction to take place. The end user inputs information, and the machine transacts.

Smart contracts use computer code with the same result: when certain conditions are met, a transaction will take place without human intervention.59 A simple example is an automated bill paying arrangement. On the bill’s due date, software causes the bill to paid by debiting an account using preset instructions.

For corporations using blockchain technology, the stock ledger can accommodate a smart contract. The ability to use smart contracting principles to design smart shares should be an attractive administrative tool for companies with complex capital structures in which different classes or series of preferred stock carry different voting rights, conversion rights, payment rights, and other features. By accurately programming these features into the stock ledger up front, a complex capital structure can be administered automatically, without human intervention. If, for example, the corporation wishes to issue additional shares, but a particular series of preferred stock has a blocking right, then the stock ledger could be coded to prevent the shares from being issued unless the requisite vote is received. Smart contracting technology also could be used to implement conversion provisions and would simplify the often difficult task of calculating conversion rates, particularly when anti-dilution formulas come into play. If the features were programmed accurately up front, then the calculations would take place automatically.

Blockchain technology also can facilitate communications, as the Delaware statute contemplates. Using a blockchain-based stock ledger, a corporation could send information to all current stockholders via the blockchain. Notices could be sent electronically with a high degree of confidence that it would reach beneficial stockholders without paying intermediaries that would otherwise make a paper or electronic delivery. In a permissioned ledger, stockholders could be given permission to communicate with other holders for particular purposes. With corresponding reforms

57. Mills et al., supra note 13, at 14.
58. Neuburger, supra note 29.
The potential to customize a blockchain enables corporations to meet public policy goals or to respond to private needs. A person can design a blockchain to mask the identity of its transactors. Where regulators may require transparency, which may be important where know-your customer and anti-money laundering issues arise, a blockchain can require its users reveal their identities. If stockholders of a private corporation prefer to mask their identity, a ledger can completely anonymize transactors, or provide the corporation’s directors only the ability to view their stockholders’ identities. And while intermediaries may not be necessary for a blockchain to process transactions, beneficial owners could still employ agents to process transactions on their behalf. Most features of a blockchain can be customized to meet the policy or business needs of its users.

It is important to stress that blockchain technology does not eliminate all human involvement, nor does it offer a smooth path to an idyllic future. To return to the vending machine example, a human must stock the machine, maintain it, and be ready to intervene if the machine breaks down for an unexpected reason. For smart contracts, a human must translate the agreement into code, oversee the system, and be ready to intervene if the code generates an unexpected result. If there are errors in the code, then the fact that the code executes automatically may not be an advantage. The old computer adage of “Garbage In, Garbage Out” will apply equally to smart contracts. So will the maxim that “[t]o err is human, but to really foul things up requires a computer.”

V. LONGER-TERM IMPLICATIONS

A more distant possibility is for blockchain-powered stock ledgers to eliminate the need for DTC. Under the current federal policy of share immobilization, record ownership for the vast majority of shares is held in the name of Cede. Beneficial ownership, by contrast, is distributed initially among the 800+ participating members in DTC and, through them, the clients of the participating members in DTC, end-users.

Blockchain technology offers a way to track share ownership without a central ledger maintained by a single institution. It therefore offers a way to reunify beneficial and record ownership. The principal benefit of such a reunification would be a reduction in transaction costs. Issuers (and their stockholders) would not have to pay fees to DTC or its participating members to serve as the nominee of beneficial holders. Nor would they face the additional expendi-


tures of time and resources that are necessary to participate in a bifurcated system. It might turn out that stockholders and issuers would still want to obtain services from DTC or from custodial banks and brokers, but the use of those services would be driven by the market, rather than a federal policy of share immobilization.

Reunification of beneficial and record ownership also would improve the integrity of corporate law. The distinction between record and beneficial ownership can undermine the legitimacy of stockholder voting. As the SEC has noted, “[b]ecause the ownership of individual shares held beneficially is not tracked in the U.S. clearance and settlement system[,] . . . imbalances occur.” When those imbalances occur, “broker-dealers must decide which of their customers will be permitted to vote and how many shares each customer will be permitted to vote.” “Some [broker-dealers] simply reduce the number of proprietary position votes cast . . .”—broker-dealers just take votes off the table. Distributed ledger technology can help ensure that voting outcomes actually reflect voter preferences.

The division between record and beneficial ownership also creates process-related headaches that can cost real money. Consider the Dell appraisal litigation. T. Rowe Price publicly opposed the management-led buyout of Dell Inc. But to vote against the merger, T. Rowe Price had to instruct Institutional Shareholder Services to instruct Broadridge Financial Solutions to exercise a proxy on behalf of Cede (DTC’s nominee) to vote T. Rowe Price’s shares against the merger and deliver those instructions to Dell’s transfer agent. T. Rowe Price thought it voted against the merger. In reality, it voted for the merger. T. Rowe Price sent incorrect instructions to Institutional Shareholder Services without knowing it, which forwarded those instructions to Broadridge, which forwarded those instructions to Cede. The error caused T. Rowe Price to lose its standing to seek appraisal, and with it, a potential award of $200 million.

Blockchain technology also potentially could enable the immediate or same-day settlement of securities (so called T+0). The SEC recently shortened by one business day the amount of time it takes to settle a transaction for most transactions involving broker-dealers, moving from three business days after the trade date (T+3) to two business days after the trade date (T+2). The SEC regards faster settlement as a means of enhancing liquidity by smoothing the flow of capital. Blockchain technology permits direct owner-to-owner transfers of securities, without the need for an intermediary. Equally important, blockchain technology also permits the direct, owner-to-owner transfer of funds, again without the need for an intermediary. Blockchain-powered stock ledgers could incorporate a require-
ment for contemporaneous transfers of value via bitcoins (or some other coin), thereby bypassing the central intermediaries for both the share transfer and the clearance of funds.

Changes to the securities markets of this magnitude are not something that Delaware can or should accomplish on its own. It will require action at the federal level, where the interests and concerns of multiple constituencies can be addressed. The potential, however, is real, and private actors and the SEC already have started having discussions.68

VI. OTHER POSSIBLE IMPLICATIONS

The ability of companies to create blockchain-driven coins with particular attributes is already emerging as a disruptive technology for capital-raising and entity governance. The ability of issuers to use blockchain technology to design coins that carry particular property rights will push the boundaries of federal securities law and state corporation law. Because blockchain technology lowers the cost of complex securities, issuers are likely to generate more of them. This in turn may lead to a revolution for equity investors that parallels what collateralized debt obligations achieved for fixed-income investors. It also has the potential to lead to greater demand for direct involvement by investors in corporate decision making.

Businesses are already using coin offerings to raise meaningful amounts of money. Diverse, blockchain-powered companies have successfully raised funds, including companies that provide platforms for blockchain-based internet data-storage,69 the processing of derivative transactions,70 and the registering and tracking of diamonds.71 In 2017, nearly $5 billion72 had been invested in blockchain-powered companies through initial coin offerings, a relatively unregulated process by which blockchain powered platforms sell native coins similar to bitcoins (“ICO”).73

At present, many coin offerings give their owners rights regarding a product.\textsuperscript{74} Golem, for example, sold tokens in an ICO that could be used to rent computing power from other participants on the network. Participants who devoted their computer to the network automatically received a portion of the tokens in return. The token holders did not possess other rights, such as the ability to influence the protocol’s development or a share of the protocol’s profits.

But more ambitious coin offerings are possible. At the extreme is The DAO, an investor-directed venture capital fund that took its name from an acronym for decentralized autonomous organization.\textsuperscript{75} Though now mired in controversy over a high-profile hack that resulted in the theft of $50 million, The DAO, as a concept, is provocative.\textsuperscript{76} The DAO was created on the Ethereum blockchain using open-source code and crowdfunded through a token sale. It did not have a board of directors, senior management team, or other centralized structure. The plan was for coin holders to determine how to deploy the fund’s capital by voting on a case-by-case basis.\textsuperscript{77}

Between product-focused coin offerings and The DAO lies a wide range of possibilities for coins that carry some form of governance or economic rights. The governance rights could range from the ability to vote on particular types of transactions or business decisions to the ability to select boardroom observers, elect directors, or pick other company personnel. The economic rights could include cash flows from a specific product line or venture.

Coin offerings of this type will raise a range of questions under both the federal securities laws and Delaware law. Regulators, issuers, and advisors have begun focusing on the federal securities law questions.\textsuperscript{78}

Less attention has been given to the Delaware law issues. For example, is a coin offering that carries a package of governance and economic rights simply a third-party commercial contract, or does it implicate the internal affairs of the entity so as to bring it within the scope of the DGCL? If the coin comes within the scope of the DGCL, is it a right issued under section 157, a share of stock issued under section 151, or something else? If the package of governance and economic rights mirrors what an investor traditionally would receive when investing in common or preferred stock, will the validity of those rights turn on compliance with provisions of the DGCL that govern stock, such as a requirement that any specific rights, powers, preferences, or privileges appear in the certificate of incorporation?


\textsuperscript{75} See generally David Siegel, Understanding the DAO Attack, COINDESK (June 25, 2016, 4:00 PM), https://www.coindesk.com/understanding-dao-hack-journalists/.

\textsuperscript{76} Klint Finley, A $50 Million Hack Just Showed that the Dao Was All Too Human, WIRED (June 18, 2016, 4:30 AM), https://www.wired.com/2016/06/50-million-hack-just-showed-dao-human/.

\textsuperscript{77} See generally Siegel, supra note 75.

Delaware law generally eschews bright-line, one-size-fits-all rules, so the answers to these questions are likely to depend on case-by-case assessments of the particular terms of a coin. Assuming that blockchain technology succeeds in lowering the costs of designing and issuing different types of coins, then corporations, their advisors, and the courts may confront a variety of difficult questions.

On the broadest level, the use of coins to provide tailored governance and economic rights may heighten tensions over the extent to which large investors exert influence over corporations and their boards of directors. Scholars and commentators hotly debate the costs and benefits of the separation of ownership and control. Delaware law comes down strongly in favor of a board-centric model in which the business and affairs of the corporation are governed by or under the direction of a board of directors, except as otherwise provided in the certificate of incorporation.79 As the stockholder base has become more organized and active, investors have become more vocal in seeking to influence management.80 Coins with tailored governance and economic rights offer both the promise and peril of coin holders seeking, and potentially obtaining, an even greater voice in determining the direction of the firm.

VII. Conclusion

At their most basic level, the blockchain amendments ensure the validity of shares that have been issued and maintained using distributed ledger technology. More broadly, they promise change on multiple levels. In the near term, they have the potential to simplify the administration of a Delaware corporation’s stock ledger, particularly for privately held companies with complex capital structures. In the medium term, they may change how private issuers interact with their stockholders through the use of smart contracts. Over the longer term, and with the benefit of corresponding reforms by the SEC, the blockchain amendments could help reunite the now-separate concepts of beneficial and record ownership, with benefits for both federal and state law. Issuers and practitioners should consider how they can best make use of the authority that the blockchain amendments have provided.