

Legal Aspects of Smart Contract Applications

Digital Asset Sales and Capital Markets, Supply Chain Management, Land Registries, Government Records and Smart Cities, and Self-Sovereign Identity



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Introduction

Smart contracts have received significant attention from legal academics and attorneys for the impact they may have on contract law and the role of lawyers. Some have also identified and described a series of use cases for smart contracts. However, the literature currently lacks a discussion of the legal implications of those use cases that are unrelated to contract law. To fill that gap, this white paper offers an initial analysis of the legal aspects of five prominent smart contract use cases: digital asset sales and capital markets, supply chain management, smart government records and smart cities, real estate land registries, and self-sovereign identity. We conclude that legal risk is inherent in each of these subject areas, but that with careful risk mitigation planning, companies can overcome those hurdles to offer effective products and services.

This white paper proceeds in four parts. Part I briefly defines the terms blockchain and distributed ledger technology as used for the purposes of this white paper and then briefly surveys the relevant technological characteristics of smart contracts, the platforms upon which they operate, and the challenges that face those creating and executing them. In Part II we review the current literature from both leading industry groups and academia regarding smart contracts and explain the importance of smart contracts for businesses and lawyers. Part III introduces five uses of smart contracts in business and government processes, and examines the legal regime(s) applicable to each. Finally, in Part IV we offer insight into practical steps a business may take when launching a product or service that uses smart contracts to mitigate legal risk.

I. A (VERY) BRIEF INTRODUCTION TO SMART CONTRACTS

The term “smart contract” is widely used, and at times misused. For example, the term is frequently used when considering whether natural language contracts can be adequately translated into computer code, or whether computer programs can themselves represent a legally binding contract.¹ Although interesting questions, these are not the primary issues in play for most smart contract implementations. To avoid adding to the definitional confusion that often plagues smart contract discussions, and to provide a common starting point for the rest of our analysis regarding the legal aspects of smart contract applications, this white paper begins by offering a brief introduction to smart contracts.

THE ORIGINS OF SMART CONTRACTS

The idea of smart contracts originated as early as 1994, when Nick Szabo first coined the term, using it to refer to “a computerized transaction protocol that executes terms of a contract.”² Szabo’s original idea of smart contracts was broad enough “that he considered ‘digital cash protocols’ to be a ‘fine example of smart contracts.’”³ Szabo’s idea lay dormant for many years because the technology did not yet exist to support the implementation of smart contracts.⁴ Then, in 2009, the Bitcoin blockchain emerged—itsself a limited form of a smart contract.⁵ Later, Ethereum offered enhanced ability to build more complex smart contracts by using a specific smart contract language (Solidity) to enable developers to write complex processes in a short span of code.⁶ The rise of these protocols led to the resurgence of the smart contract idea and its increasing popularity as a tool for enhancing business processes and efficiencies. Integrating Szabo’s original idea into the new technological age of blockchains, however, has proved more difficult than, perhaps, initially anticipated.

¹ For a detailed review of the contract law questions, and what smart contracts can teach about contract law, see Devin Werbach & Nicolas Cornell, *Contracts Ex Machina*, 67 DUKE L.J. ____ (forthcoming 2017) and NOTON ROSE FULBRIGHT, CAN SMART CONTRACTS BE LEGALLY BINDING CONTRACTS? (Nov. 2016), <http://www.nortonrosefulbright.com/knowledge/publications/144559/can-smart-contracts-be-legally-binding-contracts>.

² NICK SZABO, SMART CONTRACTS (1994).

³ Carla L. Reyes, *Conceptualizing Cryptolaw*, 96 NEB. L. REV. ____, at 15 (forthcoming 2017) (quoting SZABO, *supra* note 2).

⁴ William Mougayar, *9 Myths Surrounding Blockchain Smart Contracts*, COINDESK (Mar. 23, 2016), www.coindesk.com/smart-contract-myths-blockchain/.

⁵ Reyes, *supra* note 3, at 15; RICHARD GENDAL BROWN, A SIMPLE MODEL FOR SMART CONTRACTS, (Feb. 10, 2015), <http://gandal.me/2015/02/10/a-simple-model-for-smart-contracts/>.

⁶ WILLIAM MOUGAYAR, THE BUSINESS BLOCKCHAIN: PROMISE, PRACTICE AND APPLICATION OF THE NEXT INTERNET TECHNOLOGY (2016).

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SMART CONTRACTS IN A DISTRIBUTED LEDGER TECHNOLOGY WORLD

The Bitcoin blockchain, Ethereum, and other similar software protocols which we refer to broadly in this white paper as Distributed Ledger Technology (DLT), reignited the viability and usefulness of smart contracts. We use the term “DLT” broadly to refer to “computer software that is distributed, runs on peer-to-peer networks, and offers a transparent, verifiable, permanent transaction management system maintained through a consensus mechanism rather than by a trusted third-party intermediary, and that guarantees execution.”⁷ We recognize that there exists a vivid debate about the appropriate use of the terms “blockchain” and “DLT” to describe various applications in the industry. We do not intend to engage in that debate here, nor does our adoption of the term “DLT” in this white paper reflect a position on that debate. Rather, we use the term “DLT” with the intention that it broadly encompass various forms of decentralized and distributed technology that have relevance to smart contract applications. The term “DLT” is increasingly being used in academic literature and among standard-setting bodies as the broadest term, covering the Bitcoin blockchain, the Ripple protocol, Ethereum, and others.⁸ Further, DLT is broad enough to capture emerging platforms such as R3’s Corda. DLT also encompasses both proprietary (permissioned) DLT⁹ and open source (permissionless)¹⁰ DLT.¹¹ For the purposes of this white paper, using the broadest possible term allows us to convey the important reality that the legal issues discussed here are equally applicable to smart contract applications built upon any blockchain protocol or platform.

In the world of DLT, a smart contract is “a computer protocol—an algorithm—that can self-execute, self-enforce, self-verify and self-constrain the performance of” its instructions.¹² So conceived, it is clear that smart contracts are not the same as blockchain; rather, “smart contracts are usually part of a decentralized (blockchain) application.”¹³ The Bitcoin blockchain itself is a smart contract with the limited purpose of executing transactions that involve the exchange of assets.¹⁴ However, DLT also enables smart contracts that go beyond simple funds transfers by embedding more extensive instructions into their computer code. In fact, some DLT protocols are specifically designed to enhance the ability of software developers to build applications that rely on more complex smart contracts. For example, Ethereum, with its smart contract-specific programming language Solidity, “allows you to program the future, to implement rules governing the array of possibilities that fan out from the present.”¹⁵

⁷ Reyes, *supra* note 3, at 9 (citations omitted).

⁸ See, e.g., Werbach & Cornell, *supra* note 1, at 11 (“Underlying Bitcoin is a technology called the blockchain, or more generally, distributed ledgers.”); Kevin Werbach, *Trustless Trust*, at 2 & n.2 (Aug. 14, 2016), available at <https://ssrn.com/abstract=2844409> (“There is not yet agreement on terminology. Technically, a blockchain (sometimes rendered as block chain) is a data storage system using sequentially signed blocks . . . ‘The Blockchain’ may describe the universe of blockchains (similar to ‘the internet’), the subset of public blockchains, or just the public ledger for Bitcoin. ‘Distributed ledger’ is a more general term for the primary application of blockchains.”); Hossein Kakavand & Nicolette Kost De Severs, *The Blockchain Revolution: An Analysis of Regulation and Technology Related to Distributed Ledger Technologies*, at 4 (Jan. 1, 2017), available at <https://ssrn.com/abstract=2849251> (“Blockchain, the technology underlying Bitcoin, is a type of Distributed Ledger Technology (‘DLT’) . . .”); Sinclair Davidson, Primavera De Filippi & Jason Potts, *Disrupting Governance: The New Institutional Economics of Distributed Ledger Technology* (July 19, 2016), available at <https://ssrn.com/abstract=2811995>; Andrea Pinna & Wiebe Ruttenberg, Distributed Ledger Technologies in Securities Post-Trading, European Central Bank (Apr. 2016), available at <https://www.ecb.europa.eu/pub/pdf/scpops/ecbop172.en.pdf>; Carla L. Reyes, Nizan Geslevich Packin & Benjamin P. Edwards, *Distributed Governance*, 59 WM. & MARY L. REV. ONLINE L., at 5-7 (forthcoming 2017).

⁹ “Permissioned DLT” is used here to refer to DLT that is developed and used on a proprietary basis, and that is often not public. Angela Walch, *The Bitcoin Blockchain as Financial Market Infrastructure: A Consideration of Operational Risk*, 18 NYU J. LEGISLATION & PUB. POL’Y 837, 840 & n. 15 (2015).

¹⁰ “Permissionless DLT” is used here to refer to open source DLT—generally public ledgers, open for anyone to inspect. *Id.*

¹¹ We also recognize that an ongoing debate exists regarding the terms “distributed” as opposed to “decentralized,” and “transparent” as opposed to “public.” Again, we adopt “distributed” and “transparent” for the purposes of this white paper without any intention to engage in or state a position in that debate. For the purposes of our legal analysis, it is useful to recognize that even when DLT is permissioned, it is possible to give certain outsiders (e.g., regulators) keys to the protocol for the purpose of inspection and audit. As such, permissioned DLT remains transparent, even if it is not public in the same way as permissionless DLT. Similarly, although we are aware that many object to the basic premise of permissioned DLT in so far as the concept necessarily means the protocol is not as decentralized as the permissionless originals, we use “distributed” as opposed to “decentralized” because permissioned DLT exists and is in use. As a result, the legal discussion in this white paper must consider both forms of DLT, otherwise, our analysis would only partially address the current landscape of the technology and the law. For further discussion and rationale on the definitional choices made here, see Reyes, *supra* note 3, at 8-9 & nn. 24, 27.

¹² TIM SWANSON, GREAT CHAIN OF NUMBERS: A GUIDE TO SMART CONTRACTS, SMART PROPERTY AND TRUSTLESS ASSET MANAGEMENT 312 (2014).

¹³ MOUGAYAR, *supra* note 6.

¹⁴ BROWN, *supra* note 5, at 2.

¹⁵ HENNING DIEDRICH, ETHEREUM 67 (2017). “Ethereum has its focus on smart contracts instead of on being exclusively a digital currency. And as part of that, Ethereum transactions can be way more sophisticated than Bitcoin’s: full-fledged, high language programs, some many thousand lines long, which can call on each other, almost ad infinitum.” *Id.* at 39.

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More specifically, “[a] smart-contract is an event-driven program, with state, which runs on a replicated, shared ledger and which can take custody over assets on that ledger.”¹⁶ This definition to as follows:

- Smart contracts are software programs that run on DLT;
- Smart contracts are usually part of an application running on DLT, rather than standing alone as a DLT application;
- Smart contracts offer event-driven functionality—when triggered by external data, smart contracts will modify other data;
- External data can be supplied by “oracles”—trusted data sources that send information to smart contracts (not all smart contracts require oracles);
- Smart contracts can, acting on information provided by oracles, “enforce a functional implementation of a particular requirement, and can show proof that certain conditions were met or not met”;¹⁷
- Smart contracts can track changes in state over time;¹⁸
- Smart contracts are not the same thing as Ricardian contracts, which are “semantic representations that can track the liability of an actual agreement between parties”;¹⁹
- Smart contracts are autonomous in that the software developer who created them need not actively maintain, monitor, or even be in contact with them while they operate;²⁰
- Once operating, smart contracts may be self-sufficient, in that they can be programmed to “marshal resources—that is, raising funds by providing services or issuing equity, and spending them on needed resources, such as processing power or storage;”²¹
- Smart contracts are distributed because they exist as software running on a DLT protocol that itself is distributed across a variety of network nodes;²² and
- Smart contracts guarantee execution of the contemplated transaction.²³

Clearly, smart contracts offer the capacity to revolutionize any number of traditional processes, including those we discuss in further detail below. As technologists and businesses craft new and existing uses of this technology, the law will struggle to keep pace. Our aim in this white paper is to provide an initial consideration of several smart contract application uses under current legal regimes. We also offer reflections and predictions on which legal issues and questions will be most important for smart contract applications moving forward. We begin our investigation of the legal aspects of smart contracts with a review of the currently available literature from academics and legal professionals regarding smart contracts.

¹⁶ BROWN, *supra* note 5, at 7.

¹⁷ Mougayar, *supra* note 4, at 2

¹⁸ DIEDRICH, *supra* note 15, at 20. “State refers to “all or part of the data that a program deals with.” *Id.* Computer code that remembers things, then, is “stateful” computer code. DLT in general, and Ethereum in particular, is for stateful applications. As Vitalik Buterin explains, “[a]ll blockchains have a notion of a history—the set of all previous transactions and blocks and the order in which they took place—and the state—‘currently relevant’ data that determines whether or not a given transaction is valid and what the state after processing a transaction will be. Blockchain protocols also have a notion of a state transition rule: given what the state was before and given a particular transaction, (i) is the transaction valid, and (ii) what will the state be after the transaction?” VITALIK BUTERIN, ETHEREUM PLATFORM REVIEW: OPPORTUNITIES AND CHALLENGES FOR PRIVATE AND CONSORTIUM BLOCKCHAINS.

¹⁹ Mougayar, *supra* note 4, at 2.

²⁰ MELANIE SWAN, BLOCKCHAIN: BLUEPRINT FOR A NEW ECONOMY 16 (2015).

²¹ *Id.*

²² *Id.*

²³ DIEDRICH, *supra* note 15.



II. CURRENT ACADEMIC AND INDUSTRY LITERATURE ON SMART CONTRACTS

To date, most of the discussion among both attorneys and academics regarding smart contracts centers on contract law. Because of its prominence in the marketplace and the literature, we review that discussion here. We also review prominent literature regarding the difficulty of safely implementing smart contracts. Finally, we use this literature review as an opportunity to highlight the differences between the contract law discussion and the legal aspects of smart contract applications that emerging use cases will confront in the near term.

SMART CONTRACTS AND CONTRACT LAW

Much of the current analysis applying law to smart contracts centers on contract law.²⁴ Such analysis focuses on smart contracts in a narrower sense than described above, centering on “a spectrum of possibilities for smart contracts, ranging from contracts that merely automate implementation or performance of natural language contracts (e.g., the release of payments under a natural language contract) to contracts entirely written in code.”²⁵ In other words, most existing legal analysis focuses on “the use of computer code to articulate, verify and execute an agreement between parties.”²⁶ Under a contract law analysis, key legal issues include notice, consent, and consumer protection—similar to the oft-litigated issues in the click-wrap and browse-wrap context.²⁷ Others consider challenges under traditional concepts of fraud, force majeure and frustration.²⁸ Still others view smart contracts, when used to make execution of a legal agreement automatic, as merely a new form of self-help that fits rather neatly within existing contract law.²⁹

As a result, most of the literature considering smart contracts concludes that traditional contract law will continue to apply in a smart contract era, and that “smart contracts will never fully replace natural-language law.”³⁰ Authors also predict that conducting legal contracts through smart contracting computer code can bring clarity, predictability, auditability, and ease of enforcement to contractual relations.³¹ Such analysis of smart contracts as varying forms of legal contracts offer both useful and productive insights into the changing legal landscape. As the discussion below will demonstrate, however, many of the use cases for smart contracts currently do not involve implementing the terms of legal contracts through computer code. Rather, current use cases often offer software as a service, similar to existing business models. The difference, of course, is that the software is DLT-based and incorporates smart contract functionality. This white paper offers the first initial consideration of the additional legal regimes that will bear upon such service offerings.

²⁴ See, e.g., CHAMBER OF DIGITAL COMMERCE SMART CONTRACTS ALLIANCE, SMART CONTRACTS WHITEPAPER (Dec. 2016); Alexander Savelyev, *Contract Law 2.0: Smart Contracts As the Beginning of the End of Classic Contract Law*, Higher School of Economics Research Paper No. WP BRP 71/LAW/2016 (Dec. 14, 2016), https://papers.ssrn.com/sol3/papers2.cfm?abstract_id=2885241; Werbach & Cornell, *supra* note 1; Max Raskin, *The Law of Smart Contracts*, __ GEO. TECH. REV. (forthcoming).

²⁵ CHAMBER OF DIGITAL COMMERCE, *supra* note 24, at 49.

²⁶ John Stark, *How Close Are Smart Contracts to Impacting Real-World Law?*, COINDESK (Apr. 11, 2016), <http://www.coindesk.com/blockchain-smarts-contracts-real-world-law/>.

²⁷ CHAMBER OF DIGITAL COMMERCE, *supra* note 24, at 50-51.

²⁸ Lee Bacon, Nigel Brook & George Bazinas, “Smart Contracts:” *Where Law Meets Technology*, CLYDE&Co (June 22, 2016), <http://www.clydeco.com/insight/article/smart-contracts-where-law-meets-technology>.

²⁹ Raskin, *supra* note 24.

³⁰ Stark, *supra* note 26.

³¹ *Id.*



TECHNICAL DIFFICULTY POSED BY SMART CONTRACT DEVELOPMENT

A second set of literature involves substantial research demonstrating that correctly coding smart contracts to do what the software developer intends can be more difficult than programming traditional software.³² Furthermore, the self-executing nature of DLT causes even small errors to have significant effects.³³

For example, the Ethereum-based decentralized autonomous organization, commonly referred to as “The DAO,”³⁴ operated pursuant to smart contracting computer code. The code contained a known bug (that programmers were actively working to fix) which ultimately allowed one of The DAO’s participants to divert 3.6 million ether (ETH), roughly valued at \$50 million, into a “child DAO” controlled only by that participant.³⁵ The DAO programmer, Christoph Jentzsch, “is an Ethereum veteran with a university degree in theoretical and mathematical physics. He is not a seasoned coder or software system architect. But he is a smart guy who understands Ethereum. He even had professional experience as a software tester.”³⁶ In other words, even well-educated computer scientists with experience in the field and a deep understanding of Ethereum can make mistakes when programming with smart contracts. “That even he can trip up, predicts that a lot of people trying their hands at smart contracts will.”³⁷ In fact, because of the difficulty of coding smart contracts, the leaders in the industry are advancing efforts to develop standard smart contract code audits. The point here is that, in addition to any other substantive legal issues triggered by the particular smart contract use case, businesses offering smart contract-based services should remain mindful of potential liability relating to mistakes in programming. Such legal issues may include product liability, breach of (the software as a service) contract, unfair and deceptive trade practices, and cybersecurity, among others.

EMERGING USE CASES TOUCH UPON ENTIRELY DIFFERENT LEGAL REGIMES

With this existing landscape of legal and computer science research in mind, this white paper uses as its starting point reports of developing smart contracts use cases. In the subsequent section, we offer an overview of four such use cases, explain how smart contracts make them possible, and provide an introductory discussion of the applicable legal regimes.

III. EXPLORING THE LEGAL ASPECTS OF SMART CONTRACT APPLICATIONS

This section explores five emerging uses of smart contracts: digital asset sales and capital markets, real estate registries, smart government records, supply chain management, and self-sovereign identity. We first provide the context that led to the application of smart contracts in each area. We then offer a brief discussion of potential legal issues that will arise as projects in each area become more prominent and more frequent.

³² Kevin Delmolino, Mitchell Amett, Ahmed Kosba, Andrew Miller & Elaine Shi, *Step by Step Towards Creating a Safe Smart Contract: Lessons and Insights from a Cryptocurrency Lab*, <https://eprint.iacr.org/2015/460.pdf> (“Our lab experiences show that even for very simple smart contracts (e.g., a ‘Rock, Paper, Scissors’ game), designing and implementing them correctly was highly non-trivial.”).

³³ *Id.*

³⁴ “The DAO is the name of a particular DAO, conceived of and programmed by the team behind German startup Slock.it—a company building ‘smart locks’ that let people share their things (cars, boats, apartments) in a decentralized version of Airbnb.” David Siegel, *Understanding the DAO Attack*, COINDESK (June 25, 2016), <http://www.coindesk.com/understanding-dao-hack-journalists/>. Generally speaking, however, “A DAO is a Decentralized Autonomous Organization. Its goal is to codify the rules and decision-making apparatus of an organization, eliminating the need for documents and people in governing, creating a structure with decentralized control.” *Id.*

³⁵ *Id.*

³⁶ DIEDRICH, *supra* note 15, at 54.

³⁷ *Id.*



SMART CONTRACTS IN DIGITAL ASSET SALES AND CAPITAL MARKETS

How Are Smart Contracts Used in Digital Asset Sales and Capital Markets?

The potential uses of smart contract applications in digital asset sales and capital markets include sales of tokenized goods and services, crowd sales, venture capital fundraising, tokenized securities, syndicated loans, cash equities, collateral tracing, and leveraged loan trading. In particular, the use of smart contracts for token sales related to tokenized goods and services continues to grow. Many DLT protocols, including the Bitcoin and Ethereum blockchains, depend on intrinsic tokens (e.g., bitcoin and ether, respectively). These intrinsic tokens encourage users to validate transactions, impose minor transaction costs that prevent spam but do not discourage legitimate activity, and give the token-holder the right to participate in the network. Smart contracts enable non-intrinsic tokens to exist on top of blockchains, and in fact, many of the most popular recent uses of smart contracts involve issuing tokens that adhere to an Ethereum-based standard known as “ERC20.” Tokens designed in accordance with the ERC20 token standard are not intrinsic to the Ethereum blockchain, but are compatible with an Ethereum wallet and can readily implement other Ethereum token smart contracts.³⁸ In practice, this means that a smart contract implemented with the ERC20 standard can enable the creation of a digital token in the Ethereum ecosystem that represents any fungible good, such as coins, gold certificates, loyalty points, IOUs, or in-app credits.³⁹

Recently, many companies have used the sale of such smart-contract-based tokens as a form of democratized crowd sale, and many have experienced considerable fundraising success through DLT token sales.⁴⁰ In 2016, around 65 major⁴¹ token sales, when taken together, raised over \$225 million.⁴² The average amount of funds raised in a single token sale was \$1.6 million, while the median amount raised was \$500,000. Because of the Ethereum protocol’s sophisticated smart contract capabilities, most of these token sales involved Ethereum-based ERC20 tokens.⁴³ To describe the scenario in traditional venture capital terminology:

“[t]he Ethereum smart contract says, ‘I’m investing one bitcoin’—let’s say it’s worth \$1,000—‘and at the end of the crowdsale I get \$1,000 worth of that token.’ The smart contract is actually doing the issuance of the token to the investor. Instead of having the [chief financial officer] send you share certificates, the smart contract is sending you tokens that are representing the security in that company.”⁴⁴

In many of the token sales that have taken place to date, however, the DLT tokens do not represent share certificates in any entity. Rather, by way of smart contract functionality, many of the DLT tokens sold represent a good, a service, or other access or usage rights that enable the holder of the token to participate in transactions on the token’s DLT platform. Ultimately, these sales blur the line between tokenized goods or services and tokenized financial returns, which, in turn, creates novel legal issues to assess.

Another developing use case for smart contracts in financial transactions lies in the realm of cash equities. A recent Goldman Sachs report details the potential for smart contracts to “drive greater efficiencies in the US cash equities market, primarily through streamlining the post-trade settlement and clearing process.”⁴⁵ Goldman Sachs envisions smart contracts used to “eliminate[] duplicative confirmation/affirmation steps, shrink[] the settlement cycle, and reduc[e] trading risk, which in turn should lower the industry’s cost and capital needs.”⁴⁶ In total, Goldman Sachs estimates that the use of smart contracts in these ways could result in approximately two billion dollars in cost savings could be achieved in the United States alone, with approximately six billion dollars in cost savings globally.⁴⁷ Market participants are already exploring these applications. In particular, “issuers have contemplated the issuance of securities represented digitally rather than

³⁸ The technical functions associated with the ERC20 Token Standard appear at: https://theethereum.wiki/w/index.php/ERC20_Token_Standard.

³⁹ This list of tokenized goods appears at: <https://www.ethereum.org/token>, and is not meant to be exhaustive.

⁴⁰ DLT token sales are often colloquially referred to as “Initial Coin Offerings” or “ICOs.” We do not adopt that term in this white paper, however, as it carries with it certain assumptions about the regulatory treatment that should be afforded to token sales when those assumptions do not uniformly apply, as discussed further below.

⁴¹ We use the term “major” here to refer to token sales that raised \$40,000 or more.

⁴² Brian Patrick Eha, “Why this venture capitalist wants to make traditional VC obsolete,” *American Banker* (Apr. 3, 2017), <https://www.americanbanker.com/news/why-this-venture-capitalist-wants-to-make-traditional-vc-obsolete>.

⁴³ *Id.* (quoting Brock Pierce as saying that over 80% of the ICOs occur on Ethereum because ICOs are now Ethereum’s “first killer application”).

⁴⁴ *Id.* (quoting Brock Pierce).

⁴⁵ James Schneider, Alexander Blostein, Brian Lee, Steven Kent, Ingrid Groer & Eric Beardsley, GOLDMAN SACHS: PROFILES IN INNOVATION—BLOCKCHAIN: PUTTING THEORY INTO PRACTICE at 44 (May 24, 2016), <http://www.the-blockchain.com/docs/Goldman-Sachs-report-Blockchain-Putting-Theory-into-Practice.pdf>.

⁴⁶ *Id.*; see also Chamber of Digital Commerce, Smart Contracts: 12 Use Cases for Business & Beyond, A Technology, Legal & Regulatory Introduction 20 (Dec. 2016) <https://dntax5jbd3l.cloudfront.net/images/content/1/6/v2/164979/Smart-Contracts-12-Use-Cases-for-Business-Beyond.pdf>.

⁴⁷ Schneider et al., *supra* note 45, at 44.

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by a share certificate.”⁴⁸ Additionally, the “DTC and its parent, Depository Trust & Clearing Corporation (DTCC), have committed to achieve blockchain-based enhancements to their processes.”⁴⁹ The novel legal issues presented by these trends are detailed below.

Legal Aspects of Using Smart Contracts in Digital Asset Sales and Capital Markets

Given the recent prominence of tokens and token sales, the legal issues which will arise most frequently in the near term involve analysis as to the legal nature of a smart-contract-based token and whether a token sale constitutes a securities offering, a commodities contract, some other regulated financial transaction. Depending on the legal nature of the token, particularly in the context of a crowd sale, the resulting tax consequences may present novel issues for those interested in buying or selling tokens. In the longer term, we expect legal issues will arise around using DLT-based smart contracts to facilitate efficiencies in the markets for syndicated loans, cash equities, collateral tracing, and leveraged loan trading.

Although token sales are often intended to create ecosystems for accessing services through the tokens, the sales pose a significant risk of offering a security for sale and selling securities without proper authorization. If a token sale represents offering a security for sale, Section 5 of the Securities Act of 1933 generally requires that all securities offered for sale be registered with the Securities Exchange Commission (SEC) unless an exemption applies. The federal securities laws define the term “security” very broadly to cover virtually all types of commercial financial instruments.⁵⁰ What is covered by this definition can be vague in certain contexts, and thus the U.S. Supreme Court has developed a number of tests to determine whether a particular instrument is a security. Of such tests, the Supreme Court has made clear that the *Howey* investment contract test is applicable to cases involving “unusual instruments not easily characterized as ‘securities.’”⁵¹ The factors for the *Howey* test involve (i) an investment of money, (ii) with the expectation of profits, (iii) in a common enterprise, and (iv) derived solely from the efforts of others.⁵² *Howey* is very dependent upon specific facts, however; depending on the circumstances of their issuance and the expectations of the parties, token sales could potentially be construed as “investment contracts,” and thus securities, under the federal securities laws. In fact, for many token sales, the “investment of money” and “common enterprise” prongs are satisfied, because to purchase a token you make an investment of money, and the result of your investment is either correlated to the results of other investors (i.e., token holders) or to the expertise of the token issuer. As a result, the “expectation of profits” and “solely from the efforts of others” elements of the test are often pivotal in determining whether a token sale constitutes an investment contract under federal securities laws. Because the *Howey* test is so fact dependent, the outcome for any given token sale may be different, but that outcome will influence whether a token issuer ought to either register with the SEC or avail itself of an appropriate exemption before offering the token for public sale.

On one hand, some actors pursuing the issuance of tokenized securities seek to leverage the token sale trend to sell what is explicitly recognized as a security by everyone involved. For example, the venture capital firm Blockchain Capital recently sought to conduct its own, regulatory-compliant sale of tokenized securities. The venture capital firm released the offering memorandum for a \$10 million fundraise through a month-long sale of tokenized securities in early April 2017;⁵³ the tokenized security sale began April 10, 2017,⁵⁴ with token issuance to occur on May 10, 2017, and the firm raised its \$10 million in just six hours. In order to ensure the token sale operated in compliance with current regulations, the sale was conducted by an entity incorporated in Singapore, where the Monetary Authority of Singapore’s 2014 guidance on token sales provides needed regulatory clarity.⁵⁵ Blockchain Capital availed itself of the registration exemptions afforded by Securities and Exchange Commission under Regulations S and D to allow the sale to raise money from

⁴⁸ Jesse P. Kanach, Andrew P. Cross & Mary C. Moynihan, *As Fintech Platforms Grow Up, Investment Management Firms Face the ‘Problems of Tomorrow’*, 24 INV. LAWYER 7 (Mar. 2017), available at <https://dpntax5jbd3l.cloudfront.net/images/content/1/6/v2/168892/IL-0317-Kanach.pdf>.

⁴⁹ *Id.*

⁵⁰ Section 2(a)(1) of the Securities Act of 1933 (the “Securities Act”) and Section 3(a)(10) of the Securities Exchange Act of 1934 (the “Exchange Act”) generally define the term “security,” among other things, as any note, stock, bond, debenture, evidence of indebtedness, certificate of interest or participation in any profit-sharing agreement, transferable share, investment contract, certificate of deposit, or, in general, any interest or instrument “commonly known as a security.” The Securities Act includes short-term instruments with maturities of less than nine months in its definition of “security,” while the Exchange Act excludes such short-term instruments.

⁵¹ See *Landreth Timber Co. v. Landreth*, 471 U.S. 681, 690 (1985).

⁵² See *S.E.C. v. W.J. Howey Co.*, 328 U.S. 293, 299 (1946).

⁵³ Press Release, Blockchain Capital Releases Offering Memorandum for Its \$10 Million Digital Token Offering (Apr. 3, 2017), <https://blockchaincapital.tokenhub.com/news/4>.

⁵⁴ *Eha*, *supra* note 42.

⁵⁵ *Id.*

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international and domestic investors.⁵⁶ By doing so, Blockchain Capital provided an example to the companies that the venture capital firm hopes to finance in the future, thereby mitigating the firm's risk as a fiduciary of the money belonging to others by financing only regulatory-compliant deals.⁵⁷ In so doing, Blockchain Capital's general partner is betting that the fund's groundbreaking work (such as being the first to characterize its token offering as a security sale, the first to comply with know-your-customer requirements, and the first token sale used in the context of a fund) will pave the way for a new wave of token sales in 2017.

On the other hand, tokens which do not constitute investment contracts under U.S. securities law may constitute commodities which fall under the jurisdiction of the Commodities, Futures, and Trading Commission (CFTC). The Commodities Exchange Act⁵⁸ (CEA) gives the CFTC jurisdiction over certain kinds of transactions involving commodities, generally those involving commodities derivatives, future delivery, or financing, leverage, or margin. As a point of reference, the CFTC has stated that a virtual currency is a commodity for purposes of the CEA.⁵⁹ The question of whether the CFTC would assert jurisdiction over smart-contract-based tokens thus turns on whether (i) the CFTC would construe a particular token as either a virtual currency or other commodity under its purview, and (ii) whether transactions involving such tokens fit into any of the types of transactions over which the CFTC has jurisdiction.

In alternate scenarios, where a smart contract or token serves as a digital representation of ownership of goods, the token may simply represent an electronic "document of title" as described in Article 7 of the Uniform Commercial Code.⁶⁰ Other legal constructions which may be appropriate for DLT tokens include that of a system license, or a franchise law framework.⁶¹

Depending on the nature and legal characterization of a token based on smart contract functionality, sales of tokens present novel tax questions – whether as part of a crowd sale or fundraising effort or as an independent transaction. These tax issues include questions such as how to characterize the digital asset for taxation purposes, how to assign a value or cost basis to token sales when only digital assets (i.e., no fiat currencies) are exchanged (particularly in the context of a crowd sale), and how to assign a jurisdiction to the issuance or exchange for taxation purposes. Answers to these tax questions may, in turn, influence the jurisdiction in which development teams who are building smart contract platforms and applications may choose to incorporate.

SMART CONTRACTS FOR SUPPLY CHAIN MANAGEMENT

Why Are Smart Contracts of Interest for Supply Chain Management?

The "supply chain" refers to "all the links involved in creating and distributing goods, from raw materials to the finished product that goes into the possession of the consumer."⁶² When the idea of the supply chain originally emerged, it "was a revolutionary idea that would improve visibility and control on goods and products as they moved from point A to point B."⁶³ Today's economy involves a new type of supply chain—one that is more fragmented, more complicated and more geographically diffuse.⁶⁴ "In effect, the supply chain is now an opaque and faulty process that is extremely hard to manage."⁶⁵ As a result, neither intermediate buyers nor the ultimate consumers are able to reliably confirm the value of the goods and services they purchase.⁶⁶ Further, attempts to enforce laws relating to counterfeit goods, forced labor, poor working conditions or connections to criminal activities are stymied due to the global reach and massive scale of most

⁵⁶ *Id.* Regulation S exempts sales of securities that occur outside of the United States (17 C.F.R. §230.901 *et seq.*), and Regulation D exempts sales of securities within the United States under specific circumstances, such as when the amount offered for sale falls below a specific dollar amount and/or the amount sold is limited, in whole or in part, to certain accredited or otherwise sophisticated investors (17 C.F.R. §230.501 *et seq.*).

⁵⁷ *Id.*

⁵⁸ 7 U.S.C. §1 *et seq.*

⁵⁹ See *In re BFXNA Inc., d/b/a Bitfinex*, CFTC No. 16-19 (June 2, 2016),

<http://www.cftc.gov/ido/groups/public/@lrenforcementactions/documents/legalpleading/enfbfxnaorder060216.pdf>.

⁶⁰ See UCC § 1-201(b)(16), UCC § 1-201(b)(31), and UCC § 7-101 *et seq.*

⁶¹ A SECURITIES LAW FRAMEWORK FOR BLOCKCHAIN TOKENS, an initiative of Coinbase, Coin Center, Union Square Ventures, and Consensus (Dec. 2016), available at: <https://www.coinbase.com/legal/securities-law-framework.pdf>

⁶² Ben Dickson, *Blockchain has the potential to revolutionize the supply chain*, TECHCRUNCH (Nov. 24, 2016), <https://techcrunch.com/2016/11/24/blockchain-has-the-potential-to-revolutionize-the-supply-chain/>.

⁶³ *Id.*

⁶⁴ *Id.*

⁶⁵ *Id.*

⁶⁶ *Id.*

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supply chains.⁶⁷ In other words, a new technology is needed to help control the effects of the technology at work in today's global supply chains. Many believe DLT can be that technology.⁶⁸

DLT protocols can operate as "a distributed, single source of shared truth."⁶⁹ Layer on top of that shared, trusted source of truth the capacity of smart contracts to update the state of the transaction in real time or to "trigger events that can be used to indicate the success or failure of a transaction,"⁷⁰ and many routine difficulties in supply chain management can be significantly mitigated. Specifically, a bitcoin or other decentralized virtual currency would serve as a unit of inventory, and a wallet would serve as an inventory-keeping location, such as a store, distribution center, or truck trailer.⁷¹ Under such an arrangement, the blockchain "could be used to record the balances and transfers of inventory across a distributed supply chain network."⁷² DLT could also be used to help asset owners trace the quantity and transfer of assets as they move between elements in the supply chain.⁷³ In supply chains where provenance is important, DLT could also be used to prove the source of materials and to prevent fraud and enhance capacity for accurate freight audits.⁷⁴

In one implementation of this idea, a service "enables every physical product to come with a digital 'passport' that proves authenticity (Is this product what it claims to be?) and origin (Where does this product come from?), creating an auditable record of the journey behind all physical products."⁷⁵ The service "details four key properties concerning all materials and consumables it covers: the nature (what it is), the quality (how it is), the quantity (how much of it there is) and the ownership (whose it is at any moment). Key attributes may be read and linked from pre-existing datasets such as barcodes, or newly ascribed along the way."⁷⁶ The idea is that this system allows for an unprecedented breakthrough in supply chain management—"the *uninterrupted* chain of custody from the raw materials to the end sale."⁷⁷

Legal Aspects of Using Smart Contracts in Supply Chain Management

The Dodd-Frank Wall Street Reform and Consumer Protection Act imposes supply chain responsibility obligations upon all publicly held companies. Additionally, the California Transparency in Supply Chains Act imposes obligations upon entities that "do business" in California and have annual sales of \$100 million or more. Furthermore, companies importing or exporting products across borders must deal with shipping regulations, embargo laws and regulations, export sanctions, anti-corruption and foreign corrupt practices laws, anti-money laundering requirements, anti-boycott laws and regulations, and trade remedy laws and regulations.

Additional compliance concerns are raised by the Foreign Corrupt Practices Act, the U.K. Bribery Act, the U.S. Federal Acquisition Regulations on Trafficking in Persons in Federal Contracts, the U.K. Modern Slavery Act of 2015, the European Union's Directive on Transparency and its amendments, and the proposed U.S. Business Transparency on Trafficking and Slavery Act, among other laws.⁷⁸ A business that is developing and providing DLT-based supply chain management software would be well served by staying informed of the legal context in which its supply chain clients must operate to ensure that the software it provides sufficiently enables such clients to comply with the relevant regulatory obligations.

⁶⁷ *Id.*

⁶⁸ See, e.g., Giulio Prisco, *Walmart Testing Blockchain Technology for Supply Chain Management*, BITCOIN MAG. (Dec. 21, 2016), https://bitcoinmagazine.com/articles/walmart-testing-blockchain-technology-for-supply-chain-management-1482354996/?q=G&hPP=5&idx=articles&p=0&is_v=1 (describing Walmart's plans to use DLT to trace pork in China and produce in the United States).

⁶⁹ IBM BLOCKCHAIN, WHAT CAN BLOCKCHAIN DO FOR YOU?, https://www.ibm.com/blockchain/what_can_blockchain_do_for_you.html.

⁷⁰ *Id.*

⁷¹ ADRIAN GONZALEZ, ONE MORE PREDICTION FOR 2016: BLOCKCHAIN TECHNOLOGY WILL MAKE ITS DEBUT IN SUPPLY CHAIN MANAGEMENT, TALKING LOGISTICS WITH ADRIAN GONZALEZ (Dec. 21, 2015), <http://talkinglogistics.com/2015/12/21/one-more-prediction-for-2016-blockchain-technology-will-make-its-debut-in-supply-chain-management/>.

⁷² *Id.*

⁷³ *Id.*

⁷⁴ See also ADRIAN GONZALEZ, BITCOIN: A NEW SUPPLY CHAIN OPERATING SYSTEM?, TALKING LOGISTICS WITH ADRIAN GONZALEZ (Jan. 26, 2015), <http://talkinglogistics.com/2015/01/26/bitcoin-new-supply-chain-operating-system/>.

⁷⁵ BENJAMIN HERZBERG, BLOCKCHAIN: THE SOLUTION FOR TRANSPARENCY IN PRODUCT SUPPLY CHAINS, PROVENANCE (Nov. 21, 2015), <https://www.provenance.org/whitepaper>.

⁷⁶ *Id.*

⁷⁷ *Id.* For other services in the supply chain space, see Blockverify, which is trying to provide a simple way to verify the authenticity of medicine, Everledger, which is trying to bring transparency to the diamond supply chain, and Kouvola Innovation, which seeks to provide a smart tendering solution for the supply chain.

⁷⁸ For further information see PERKINS COIE, SUPPLY CHAIN COMPLIANCE & CORPORATE SOCIAL RESPONSIBILITY, <https://www.perkinscoie.com/en/practices/government-regulatory-law/white-collar-investigations/supply-chain-compliance-corporate-social-responsibility.html>.

Legal Aspects of Smart Contract Applications



SMART RECORDS FOR GOVERNMENT AND SMART CITIES

What Role Do Smart Contracts Play in Smart Government Records and Smart Cities?

Reports of governments investigating the use of recordkeeping systems deployed on the blockchain abound; such governments include the United Kingdom,⁷⁹ Estonia,⁸⁰ Dubai,⁸¹ the U.S. federal government,⁸² and various state governments in the United States (e.g., Vermont,⁸³ Delaware,⁸⁴ and Illinois⁸⁵). Some government interest can be attributed to a belief in DLT's capacity "to vastly reduce the cost and complexity of getting things done."⁸⁶ Generally speaking, government leaders expect that a DLT-based system "will be faster and cheaper than the existing process since it automates a number of processes."⁸⁷ Others feel that in addition to enhancing the transparency, security, and efficiency of existing government services, DLT-based government records may create opportunities to offer additional government services not previously possible.⁸⁸ Possibilities for revamping the U.S. personal property filing system used to record secured transactions conducted under Article 9 of the Uniform Commercial Code, and for making Bank Secrecy Act compliance less burdensome have also been suggested.⁸⁹ In fact, the European Union is presently exploring DLT's potential to lessen compliance burdens in the financial services industry.⁹⁰

In a very concrete example, the State of Illinois' Department of Innovation and Technology put out a request for information that designated four specific areas of interest: (1) identity, attestation, and ownership registries, (2) compliance and reporting ledgers, (3) benefit and entitlement ledgers, and (4) new products and other areas of interest.⁹¹ With regard to the first area of interest, Illinois is investigating how it could use DLT "to consolidate disparate data that currently exists across multiple agencies and layers of government into a single self-sovereign network centered around the citizen," and whether "a persistent, secure identity layer [could] allow Illinois to more efficiently deliver private, secure, reliable, and integrated services."⁹²

With regard to compliance and reporting, Illinois queries whether DLT can "enable businesses and individuals either required to report information or voluntarily providing information, a more trusted, transparent yet anonymous way of doing so," and whether "these reporting ledgers [could] help limit reporting to one trusted, verifiable source provided by the entity involved."⁹³

In the realm of benefits and entitlements, Illinois hopes to leverage DLT to reduce fraud and allow more efficient distribution while also increasing transparency.⁹⁴ Finally, the State of Illinois also indicated a broader interest in learning about (a) other DLT-as-a-service products, including escrow, digital notaries, public records management and digital identities, (b) possibilities for a public permissioned blockchain with network nodes and participants authenticated by the state government, and (c) using DLT to secure IoT infrastructure from cybersecurity threats.⁹⁵

⁷⁹ Emily Spaven, *UK Government Exploring Use of Blockchain Recordkeeping*, COINDESK (Sept. 1, 2015), <http://www.coindesk.com/uk-government-exploring-use-of-blockchain-recordkeeping/>.

⁸⁰ Medha Basu, *Estonia using Blockchain to secure health records*, GOV INSIDER (Mar. 6, 2016), <https://govinsider.asia/innovation/estonia-using-blockchain-to-secure-health-records/>.

⁸¹ Michael del Castillo, *Dubai Wants All Government Documents on Blockchain By 2020*, COINDESK (Oct. 5, 2016), <http://www.coindesk.com/dubai-government-documents-blockchain-strategy-2020/>.

⁸² Pete Rizzo, *Department of Homeland Security Calls for Blockchain Research*, COINDESK (Dec. 15, 2015), <http://www.coindesk.com/department-of-homeland-security-calls-for-blockchain-research/>.

⁸³ Brian Cohen, *Vermont Considering Blockchain Tech for State Records, Smart Contracts*, COINTELEGRAPH (Aug. 5, 2015), <https://cointelegraph.com/news/vermont-considering-blockchain-tech-for-state-records-smart-contracts>.

⁸⁴ Giulio Prisco, *Delaware Blockchain Initiative to Streamline Record-Keeping for Private Companies*, BITCOIN MAG. (May 9, 2016), <https://bitcoinmagazine.com/articles/delaware-blockchain-initiative-to-streamline-record-keeping-for-private-companies-1462812187/>.

⁸⁵ CRAIG HOLLOWAY, DEPARTMENT OF INNOVATION AND TECHNOLOGY, STATE OF ILLINOIS: REQUEST FOR INFORMATION (RFI)—DISTRIBUTED LEDGER AND BLOCKCHAIN APPLICATIONS IN THE PUBLIC SECTOR,

<https://www2.illinois.gov/sites/doit/Documents/BlockchainInitiative/RFI+Blockchain+and+Distributed+Ledger+Applications+in+the+Public+Sector.pdf>.

⁸⁶ Brian Robinson, *Blockchain on the government horizon*, GCN MAG. (Mar. 22, 2016), <https://gcn.com/articles/2016/03/22/blockchain-government.aspx>.

⁸⁷ Prisco, *supra* note 84.

⁸⁸ Blake Carpenter & Adam Hughes, *Can blockchain spark a government services revolution?*, GCN MAG. (Sept. 27, 2016), <https://gcn.com/articles/2016/09/27/blockchain-government-services-revolution.aspx>.

⁸⁹ Reyes, *supra* note 3.

⁹⁰ DIEDRICH, *supra* note 15.

⁹¹ HOLLOWAY, *supra* note 85.

⁹² *Id.* at 5.

⁹³ *Id.*

⁹⁴ *Id.* at 6.

⁹⁵ *Id.*

Legal Aspects of Smart Contract Applications



The most expansive plans to use DLT and smart contracts to enable smart government and smart cities belong to the Dubai government. Dubai's stated goal is to be the first government in the world to execute all applicable transactions on DLT-based systems by 2020.⁹⁶ Achieving this goal would make Dubai the first government to pioneer DLT on a citywide scale. To that end, Dubai launched a program of flying startup companies from around the world to pilot blockchain use cases for its government. In a coordinated government agency effort, Dubai hopes to enable DLT-based systems for energy and water, transport and logistics, economic development, tourism, safety and justice, municipality and land, health, social services, and smart districts.⁹⁷ Ultimately, Dubai envisions its DLT-based government smart record and smart city program as the path to achieving key policy objectives, including: creating a lean, connected government, enabling a globally competitive economy, supporting a high quality of life, enhancing financial and economic efficiency and improving resource and infrastructure efficiency.⁹⁸ Key components of this plan involve using smart contracts in several of the other ways discussed in this white paper: to protect identity, to trace property ownership, to improve supply chain management, and in capital markets.⁹⁹

Since its launch of this effort in October 2016, Dubai has established the Smart Dubai Office Blockchain Challenge in partnership with global accelerator 1176, launched its own Smart Dubai Accelerator at the Dubai Future Accelerators, and announced initial contract awards for IBM and Consensys.¹⁰⁰ By all accounts, Dubai's plans for smart government recordkeeping and a smart city are moving forward according to schedule.

The extent to which any government incorporates smart contracting features into the DLT-based smart records application it chooses to adopt depends entirely upon the government, its goals, and the particular needs of the application. At one end, a smart records program might focus entirely on the time stamping and immutability functionality of DLT protocols; such programs might be considered a highly efficient notary and recordkeeping service with extreme transparency. At the other extreme, "an enterprising locality could offer a blockchain-based municipal bond that automatically accrues and pays interest to its holder on a pre-determined schedule."¹⁰¹

Legal Aspects of Using Smart Contracts for Smart Records and Smart Cities

Using smart contracts and DLT protocols in the context of government recordkeeping may raise important questions of administrative law.¹⁰² Given the inherent difficulties of correctly programming smart contracts applications, "[w]hat remedies will belong to the governed when the computer code makes an unexpected and/or undesirable decision? Who will be at fault if the code executes prematurely because it misread the circumstances?"¹⁰³ Although the administrative law burdens will fall to the state agencies embarking upon a smart records project, those developing DLT-based programs that incorporate smart contract features for government use must carefully negotiate their contracts with the hiring agency and pay particular attention to questions of liability for product malfunction and unexpected consequences. Furthermore, the more complicated the software programming required, the more likely the philosophies (and, at times, biases) of the software developer are to infuse the code. "[E]xtensive research evidences the extent to which developers frequently write implicit biases into the code and algorithms they create."¹⁰⁴ As a result, those businesses offering software-as-a-service solutions to governments seeking to implement a smart records regime must remain vigilant and cognizant of laws relating to antidiscriminatory practices conducted by the government.

⁹⁶ Statement attributed to His Highness Sheikh Hamdan bin Mohammed Al Maktoum from a speech made on the launch of the Dubai Blockchain Strategy, October 5, 2016, in "Smart Dubai: Dubai Blockchain Roadmap" (slide deck on file with authors).

⁹⁷ "Smart Dubai: Dubai Blockchain Roadmap" at 7 (slide deck on file with authors).

⁹⁸ *Id.* at 12.

⁹⁹ *Id.* at 13.

¹⁰⁰ Issac John, "Dubai picks IBM, Consensys to kick off blockchain project," *Khaleej Times* (Mar. 14, 2017), <http://www.khaleejtimes.com/dubai-picks-ibm-consensys-to-kick-off-blockchain-project>.

¹⁰¹ Carpenter & Hughes, *supra* note 88.

¹⁰² Reyes, *supra* note 3, at 41.

¹⁰³ *Id.* at 43.

¹⁰⁴ *Id.* at 44 (citing FRANK PASQUALE, *THE BLACK BOX SOCIETY* 110-113 (2015)).



SMART CONTRACTS FOR REAL ESTATE REGISTRIES

Why Are DLT-Based Real Estate Registries Needed?

Around the world, governments manage real property ownership rights through public land registries. Such registries, effectively operated as a centralized ledger, suffer from significant flaws, even in industrial countries, where a complicated system of real estate law has developed.

In many developing countries, land registry systems remain inefficient, inaccurate, and bloated with inequities and corruption, and in some cases, they do not functionally exist at all. In his groundbreaking book *The Mystery of Capital*, economist Hernando de Soto argued “that the major stumbling block that keeps the rest of the world from benefiting from capitalism is its inability to produce capital.”¹⁰⁵ De Soto posited that although the world’s poor “already possess the assets they need to make a success of capitalism . . . they hold these resources in defective forms,” such as real property without proper title.¹⁰⁶ The idea is that because the assets are not held by title, they “cannot readily be turned into capital, cannot be traded outside of narrow local circles where people know and trust each other, cannot be used as collateral for a loan, and cannot be used as a share against investment.”¹⁰⁷ Without proper title, an enabling mechanism for leveraging assets, the assets held by the poor members of developing nations are “dead capital,” useless for wealth generation and a stumbling block to economic development. Many believe that DLT offers an alternative method for registering and tracing real estate ownership interests more accurately and efficiently. Another claim is that blockchain-based land registries offer the opportunity to democratize real estate ownership interests by putting control over the record into the hands of the owners and thereby limiting the effect of corruption and politics that otherwise jeopardize land registries in many developing countries.¹⁰⁸

Where Are DLT-Based Land Registries Being Developed?

Examples of blockchain-based land registry proposals abound. *The Economist* reported that Factom partnered with the government of Honduras in 2015 to build a more effective land registry there, where “land registries are badly kept, mismanaged and/or corrupt,” as they are “across much of the world.”¹⁰⁹ The Republic of Georgia engaged the Bitfury Group “to advance transparency by developing a system for registering land titles using the Blockchain for the National Agency of Public Registry.”¹¹⁰ The chairman of Georgia’s National Agency of Public Registry reportedly described Georgia’s interest in building a blockchain-based land registry as follows:

By building a blockchain-based property registry and taking full advantage of the security provided by the Blockchain technology, the Republic of Georgia can show the world that we are a modern, transparent and corruption-free country that can lead the world in changing the way land titling is done and pave the way to additional prosperity for all.¹¹¹

Greece has also expressed interest in developing a blockchain-based land registry; in Greece “only 7% of the territory is adequately mapped.”¹¹² The Swedish National Land Survey unveiled its own plans to partner with ChromaWay to test a system for registering and recording land titles in an effort to digitize its real estate process.¹¹³ In West Africa, Bitland Global (“Bitland”) is developing a land registry system designed to “provide immutable records of ownership to those who normally would have difficulty” obtaining such records.¹¹⁴

¹⁰⁵ HERNANDO DE SOTO, *MYSTERY OF CAPITAL: WHY CAPITALISM TRIUMPHS IN THE WEST AND FAILS EVERYWHERE ELSE* 20 (2000).

¹⁰⁶ *Id.* at 5-6.

¹⁰⁷ *Id.* at 6.

¹⁰⁸ *Id.* at 11, 16 (“The institutions that give life to capital—that allow one to secure the interests of third parties with work and assets—do not exist here.”). Earlier in his career, De Soto explained the idea in terms of his native Peru as follows: “So far, we have seen that Peruvians are forced to assume excessively high costs in order to operate legally or, if they are unable to do so, that they have been left out of the system. This means that they cannot take advantage of the country’s good laws, namely the facilitating instruments provided by the law to make economic and social activities more efficient: property rights, contracts, and extracontractual law.” HERNANDO DE SOTO, *THE OTHER PATH: THE INVISIBLE REVOLUTION IN THE THIRD WORLD* 177 (June Abbott trans., 1990).

¹⁰⁹ *Blockchains: The great chain of being sure about things*, *THE ECONOMIST* (Oct. 31, 2015).

¹¹⁰ BITFURY, ABOUT, <http://bitfury.com/>.

¹¹¹ Stan Higgins, *Republic of Georgia to Develop Blockchain Land Registry*, COINDESK (Apr. 22, 2016), <http://www.coindesk.com/bitfury-working-with-georgian-government-on-blockchain-land-registry/>.

¹¹² *Blockchains*, *supra* note 109.

¹¹³ Pete Rizzo, *Sweden Tests Blockchain Smart Contracts for Land Registry*, COINDESK (June 16, 2016), <http://www.coindesk.com/sweden-blockchain-smart-contracts-land-registry/>.

¹¹⁴ Jamie Redman, *Bitland: Blockchain Land Registry Against ‘Corrupt Government’*, BITCOIN.COM (May 26, 2016), <https://news.bitcoin.com/bitland-blockchain-land-registry/>.



Located in Kumasi, Ghana, Bitland is a nonprofit organization “working to keep the land registration process accessible, transparent, and free from government corruption” by updating “paper data storage houses into digital format,” consolidating “new land registry requests against the old registries,” and integrating systems that local communities have developed for keeping track of titles.¹¹⁵

These DLT-based land registries rely upon the smart contract capabilities of DLT protocols. The general idea is that DLT-based land registries can leverage the capacity of smart contracts to record state changes in real estate ownership and then immutably record those changes on the chosen DLT protocol. Some of the land registry projects under development rely on public DLT protocols, while others are designed for private DLT protocols, and still others, like that of ChromaWay, are protocol and consensus-neutral such that they can be deployed on any underlying DLT protocol. By recording the changes in land ownership on a DLT protocol, these land registry projects also offer an accountability mechanism—namely, “every user of [the] service can reliably verify that the service operates in the intended way (e.g., information provided by the service agrees with the information it provided to other users).”¹¹⁶ Although the possibility of an immutable audit trail offers an attractive reason for moving land registries to DLT, DLT does not automatically solve the problem of ensuring that the data originally entered into the ledger is accurate and reliable—it merely ensures that once the data is entered, state changes to that data can be traced going forward.¹¹⁷

Legal Aspects of DLT-Based Land Registries

The most critical and obvious legal aspect of DLT-based land registries centers on the fact that most public land registries are controlled by government actors. Thus, to be legally effective, land registry processes must be developed in connection with or on behalf of the relevant government actor. Alternatively, the company might develop a platform and allow governments to adopt it as they please.¹¹⁸ Regardless of how the DLT-based land registry is adopted by the appropriate government actor, both the government and the application developer should remain cognizant of the implications that doing so will have for real estate law more broadly. Developers should be prepared to explain to their government clients how the DLT-based system interacts with, and in some respects might replace, the existing real estate laws.¹¹⁹ Further, where the DLT-based land registry is offered on a software-as-a-service (“SaaS”) basis, the company should consider traditional legal issues applicable in the SaaS context, including licensing, software code escrow, privacy and security, redundancy systems, and system-level agreements, among others. A detailed description of the issues involved in each of these areas is beyond the scope of this white paper; however, companies offering DLT-applications in this area would be well served by consulting experienced technology transactions counsel before launch.

SMART CONTRACTS FOR ENABLING SELF-SOVEREIGN IDENTITY

How Can Smart Contracts Enable Self-Sovereign Identity?

Many observers think that DLT offers an opportunity to create and validate digital identities that could replace current physical forms of identification such as a passport or driver’s license. In the digital economy, a person’s identity is often fragmented across government agencies, service providers, and business entities. Often people jeopardize the security of their own identities by using the same user name and password across platforms for ease of memory. Furthermore, the person does not retain full control of all of the pieces of their own digital identity. Instead, the person gives up control of certain identity data to the service provider, ultimately meaning that the service provider can revoke the person’s access to such data. Such revocation could, in turn, impact access to other services that is predicated upon the digital identity that has been revoked.

For example, major social networks allow a person to build a trusted digital identity by allowing that person to use his or her login credentials for their services as a proxy to log in to other services. But if a major social media platform deactivates a person’s account, that

¹¹⁵ CHRIS BATES, BITLAND GLOBAL WHITE PAPER (Jan. 11, 2016), <https://bravenewcoin.com/assets/Whitepapers/Bitland-Whitepaper.pdf>.

¹¹⁶ BitFury, *On Blockchain Auditability* (Nov. 14, 2016), http://bitfury.com/content/5-white-papers-research/bitfury_white_paper_on_blockchain_auditability.pdf.

¹¹⁷ VICTORIA L. LEMIEUX & DARA HOFMAN, BLOCKCHAIN TECHNOLOGY FOR RECORD KEEPING: HELP OR HYPE?, Vol. 2, at 40, https://www.researchgate.net/profile/Victoria_Lemieux/publication/309414363_Blockchain_for_Recordkeeping_Help_or_Hype/links/580f539408ae009606bb62f6.pdf.

¹¹⁸ For a more thorough review of how a government might, in line with administrative law constraints, adopt a DLT-based application that takes a traditional government process and moves it to a DLT-based process, see Reyes, *supra* note 3.

¹¹⁹ For an in-depth consideration of how to undertake such considerations, see Reyes, *supra* note 3.



person loses the identity he or she created on that social media platform, which could put at risk the trusted nature of their online identity with a host of other providers.¹²⁰

In this context, an ideal form of digital identity has been described as self-sovereign identity. A self-sovereign identity would offer a person control over his or her identity (including who has access to what aspects of his or her identity), would be protected from unauthorized use or disclosure, and would be portable—capable of use by the person to identify himself or herself without seeking permission from or being tied to a service provider and capable of being transferred freely without being at risk of loss.¹²¹ Holistically, a self-sovereign identity can be thought of as a repository of identity data about a person where data that supports proof of that person's unique identity can be added by the identity owner or by others at the identity owner's request.¹²²

DLT is thought to enable self-sovereign identity in ways that were previously not feasible. DLT allows the creation of a digital fingerprint by linking "attributes" to a self-sovereign identity. "Attributes" (which are also sometimes called "claims") are descriptors of a person, such as the person's name or birthdate. DLT also allows other entities to verify a person's attributes (also sometimes referred to as an "attestation"), which, in turn, allows that person to use the verified attribute in other circumstances.

For example, if a person's name and social security number are attested to by a bank, then a subsequent bank can rely on that attestation without having to independently conduct the same verification. The DLT protocol provides a security level for self-sovereign identity. DLT protocols make it exceedingly difficult for a single entity to make changes to recorded transactions without the nodes on the network becoming aware of the change and rejecting it.

Legal Aspects of Using Smart Contracts for Self-Sovereign Identity

Using a system of self-sovereign identity built on DLT protocols will allow individuals to benefit from the security and privacy built into DLT's cryptographic nature, and it may also limit a business's risk of liability for data breach or mishandling of personal data by enabling a business to rely solely upon attestations that have been signed to the ledger, and not collect any data itself. However, certain data privacy laws may be incompatible with the immutable nature of the digital identities anchored in a DLT protocol. For example, European citizens have a "right to be forgotten," and the U.S. Fair Credit Reporting Act, the Gramm-Leach Bliley Act, and the Securities Exchange Commission's Regulation S-P mandate that personal financial data be easily redacted.¹²³ Further, to the extent that any self-sovereign identity solution links biometric data to the system, there are a number of privacy laws in the United States that either specifically govern biometric data or are broad privacy laws under which biometric data may fall. Generally speaking, such laws regulate third parties' use and collection of biometric data. Some states even regulate how digital accounts are handled after the owner dies, and others are actively attempting to pass such legislation. Such laws raise the question of how to treat a self-sovereign identity repository, or account, after the person to whom the identity belongs is deceased.¹²⁴ Further, to the extent that financial institutions rely upon attestations or other elements of a self-sovereign identity to meet compliance obligations under the anti-money laundering provisions of the Bank Secrecy Act, what happens if the self-sovereign identity service provider makes an error or if the code suffers from a flaw that compromises the integrity of the attestations? In light of the complexity of coding smart contracts to accurately execute according to the designers' intended purpose, complex issues of fault, liability, and remedies may arise. Any company beginning the planning phase of a product launch in this area would do well to carefully consider each of these issues throughout the product life cycle.

¹²⁰ ANDREW TOBIN & DRUMMOND REED, THE INEVITABLE RISE OF SELF-SOVEREIGN IDENTITY: A WHITE PAPER FROM THE SOVRIN FOUNDATION 4 (Sept. 29, 2016), <https://www.sovrin.org/The%20Inevitable%20Rise%20of%20Self-Sovereign%20Identity.pdf>.

¹²¹ CHRISTOPHER ALLEN, THE PATH TO SELF-SOVEREIGN IDENTITY (Apr. 27, 2016), <http://www.coindesk.com/path-self-sovereign-identity/>; TOBIN & REED, *supra* note 120, at 6.

¹²² TOBIN & REED, *supra* note 120, at 9.

¹²³ Richard Lumb, *Downside of Bitcoin: A Ledger That Can't be Corrected*, N.Y. TIMES DEALBOOK (Sept. 9, 2016), https://www.nytimes.com/2016/09/10/business/dealbook/downside-of-virtual-currencies-a-ledger-that-cant-be-corrected.html?_r=0.

¹²⁴ For a discussion of how privacy interests are traditionally terminated at death and an exploration of how they should be revived and reshaped in a digital future, see Natalie M. Banta, *Death and Privacy in the Digital Age*, 94 N.C. L. REV. 927 (2016).



IV. AN INITIAL RISK MITIGATION CHECKLIST FOR BUSINESSES DEVELOPING SMART CONTRACTS APPLICATIONS

Although smart contract-based applications vary greatly, sufficient common elements exist to enable the companies developing them to be proactive in reducing their risk of liability exposure. We offer a preliminary, non-exhaustive checklist of such issues here, and we recommend that companies in this area reach out to experienced legal counsel at each stage of application development: when contracting with customers, when building and testing the application, and before moving the application to public deployment.

Practical issues to consider with legal counsel when developing smart contracts applications include, but are not limited to:

- ☐ What is the legal context in which the smart contract application will operate?
- ☐ Will the smart contract replace any function previously performed by government actors? If so, what features of the law need to be replicated in the application to protect the validity of the transaction, and how should the user (a state actor) expect the law to change in response to use of the smart contract application?
- ☐ What laws otherwise apply to the transactions taking place within the application? Does the application allow parties to comply with their obligations under those laws?
- ☐ What hazards are posed by use of the smart contract application alone?
- ☐ What hazards are posed by using the smart contract application with other software?
- ☐ Are there hazards that should be designed or guarded against?
- ☐ What warnings or instructions are necessary and/or advisable?
- ☐ Where and how should the warnings be displayed to limit liability exposure if the application malfunctions?
- ☐ Do you have a protocol or system of monitoring in place to assist your software developers in guarding against coding implicit biases into the smart contract application?
- ☐ What contractual provisions do you need to limit liability and maximize the availability of indemnification?
- ☐ Have you considered and properly contracted around issues unique in the software-as-a-service context?
- ☐ Have you considered and properly contracted for software code audit services?
- ☐ What privacy and security law considerations do you need to bake into the smart contract application?

CONCLUSION

In sum, smart contracts will continue to evolve as a technology, and the legal issues surrounding the technology will likewise continue to evolve and involve novel questions beyond simply contract law. We predict that smart contracts will continue to disrupt, from both a technological and legal perspective, digital asset sales, venture capital and capital markets, supply chain management, government and smart cities, real estate registries, and self-sovereign identify, as well as other use cases not yet imagined. Although legal risk remains inherent in any technology platform, we conclude that companies who engage in careful planning can and will effectively mitigate these legal risks while offering products and services that utilize smart contracts.