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Scott A. McKinney

Rachel Landy

Rachel Wilka

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Scott A. McKinney, Rachel Landy, and Rachel Wilka[*]

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ABSTRACT

Smart contracts are an emerging technology that could revolutionize commercial transactions by eliminating inefficiencies and uncertainty created by the current transactional ecosystem of lawyers, courts, regulators, banks, and other parties with divergent interests. However, a lack of consensus around how smart contracts are implemented, uncertainty regarding enforceability, and scarcity of on point statutes and case law means that a stable legal, commercial and technical smart contract landscape has yet to emerge. The implementation of universal legal, technical and commercial standards and best practices will reduce uncertainty and promote widespread adoption and use of smart contracts.

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[*] Scott McKinney and Rachel Landy are senior associates in the Technology Transactions practice at Wilson Sonsini Goodrich & Rosati, P.C. (WSGR). Scott is an adjunct professor at Georgetown Law and a guest lecturer for Cornell University's Cornell Tech grad program. Rachel represents numerous technology companies on matters relating to intellectual property and commercial contracts. Rachel Wilka is Corporate Counsel at Zillow Group, Inc. and lead counsel for Zillow Rentals, hotpads, Inc., and dotlop, Inc., supporting all product counseling, licensing, commercial partnership, and risk management matters. Rachel was previously a technology transactions associate at Wilson Sonsini Goodrich & Rosati. The views expressed in this article are the authors' own and do not represent the views of WSGR, Zillow, or any of the authors' other clients. Thank you to Manja Sachet and Rob Philbrick.

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INTRODUCTION

Every other day, the terms "smart contract," "blockchain," or "cryptocurrency," make headlines with reports of extreme cryptocurrency crashes, "pivots" to blockchain, and bold proclamations, such as that "[b]lockchain [will] replace the functions of lawyer[s]."[1] Hyperbole aside, the reality is these early-state technologies have a lot of promise, but have yet to be fully-realized by the commercial and legal worlds.

In this Article, we explore what smart contracts may mean for the law and the future of commercial contracts. Before we answer that question, however, we must first ask: how might a smart contract work in the real world?

Imagine the following: you want to buy a bushel of apples. You live in Uganda, and the best apples in the world are in the State of Washington. The apple seller, who you have never met, speaks English exclusively, but you speak only Swahili. The apple seller uses a different bank than you, and you cannot afford to pay expensive transaction fees charged by credit card companies, money transferors, or banks. You do not trust the apple seller to send the apples, and the apple seller does not trust you to send a check. How can you and the apple seller make this transaction happen?

Smart contracts provide a solution. As it turns out, the apple seller's apple bushel recognizes its GPS coordinates (enabled, of course, by "internet of things" technology) and can automatically verify (over the internet) if the apple seller sent the apples and when the apples have reached you. A smart contract ensures you would not pay any money until the apples arrive, and also ensures that,

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[1] *See, e.g.*, Cory Johnson and Olga Kharif, *Kodak CEO Plans to Seize Blockchain Moment and Win Over Skeptics*, BLOOMBERG TECHNOLOGY (Jan. 12, 2018), https://www.bloomberg.com/news/articles/2018-01-12/kodak-ceo-plans-to-seize-blockchain-moment-and-win-over-skeptics; *Stakers Enhances Betting Experience as Smart Contract Sets Into Action,* THE MERKLE (Jan. 15, 2018), https://themerkle.com/stakers-enhances-betting-experience-as-smart-contract-sets-into-action/; Selva Ozelli, *Smart Contracts Are Taking Over Functions of Lawyers: Expert Blog*, COINTELEGRAPH (Jan. 12, 2018), https://cointelegraph.com/news/smart-contracts-are-taking-over-functions-of-lawyers-expert-blog; Nathaniel Meyersohn, *Bitcoin Sinks 20%*, CNN MONEY (Jan. 16, 2018), http://money.cnn.com/2018/01/16/investing/bitcoin-price-drop-january/index.html; Robert Hackett, *IBM And Maersk Are Creating A New Blockchain Company*, FORTUNE (Jan. 16, 2018), http://fortune.com/2018/01/16/ibm-blockchain-maersk-company/.

when the apples do arrive, the apple seller automatically receives a pre-verified payment. Both sides win. This is the promise of smart contracts.

Smart contracts are models of legal efficiency, reducing the need for a complex court system to enforce transactions because the contracts themselves are self-enforcing. Cross-border transactions can occur with less risk that either party will need to go to court to enforce performance, since there is more certainty that the counterparty will fulfill its obligations under the contract. Intermediaries in contractual ecosystems (like banks and money transferors) could become obsolete. The potential applications are endless, including in the realms of finance, real estate, oil, music, art, infrastructure, intellectual property, transportation, and countless other industries.

If developed and implemented properly, smart contracts promise simplified and streamlined commercial transactions by eliminating inefficiencies and uncertainty introduced by lawyers, courts, regulators, and parties with divergent interests, and could represent a new frontier of commercial law and transactions.

In Part I, we describe how a smart contract works, including through an overview of the blockchain technology that has driven the popularity of smart contracts. In Part II, we provide an overview of some high-level legal issues with widespread use of smart contracts. Part III includes a discussion of how various industries could implement smart contracts to maximize efficiency. Lastly, in Part IV, we propose a best practices framework for smart contract implementation.

I. BACKGROUND

A. How Does a Smart Contract Work?

1. Blockchain

Smart contracts were formally proposed in 1996[2], but had been

[2] *See generally*, Nick Szabo, *Smart Contracts: Building Blocks for Digital Markets*, EXTROPY, 1996.

conceptualized in technical legal circles far earlier. Yet, it wasn't until recently that smart contracts really took off. The reason for the change is blockchain.[3] Before blockchain, the idea of smart contracts was stymied by general uncertainty, identity and transaction verification issues, and concerns that transactions would not be secure. Although blockchain is not necessary for smart contracts to function or exist (i.e., all blockchains are not smart contracts, and all smart contracts do not need to be incorporated into or use blockchain), current and near-future implementations of smart contracts are virtually all based on or tied to blockchain technology.[4]

In the past, before blockchain, both parties to a theoretical "smart contract" transaction would have had to rely on the other party's computer code and network infrastructure, trusting that both sets of code were identical (and executed in the same way on both sets of computers).[5] Blockchain's distributed ledger characteristics allow code to be embedded into a single, publicly-distributed ledger where there is no need for duplication. Every smart contract user accesses the same smart contract using the same set of code. As we further describe below, this means that blockchain is effectively tamper-proof, which gives smart contract users certainty that the deal will not be changed unilaterally and allows the transaction to be self-enforcing.[6]

Blockchain was first described by the pseudonymous Satoshi

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[3] While it is important and necessary to describe the technical functionality of blockchain and smart contract technology in some detail, this paper is aimed primarily at analysis of legal and commercial issues, so we have chosen to only describe the smart contract technology at a high level. For more in-depth information on blockchain*, see, e.g.*, Sloane Brakeville & Bhargav Perepa, *Blockchain Basics: Introduction to Distributed Ledgers*, IBM (Mar. 18, 2018), https://www.ibm.com/developerworks/cloud/library/cl-blockchain-basics-intro-bluemix-trs/. For more information on smart contract technology *see, e.g.*, Manuel Araoz, *The Hitchhiker's Guide to Smart Contracts in The Ethereum*, MEDIUM CORPORATION (Oct. 6, 2017), https://blog.zeppelin.solutions/the-hitchhikers-guide-to-smart-contracts-in-ethereum-848f08001f05?gi=3c6fdfeb292.

[4] The authors were unable to identify any mainstream or public uses of smart contracts that do not use blockchain as of the date of this paper.

[5] *See* Szabo, *supra* note 2.

[6] *Id.*

Nakamoto in the now-famous bitcoin white paper.[7] This paper describes blockchain as a progressively increasing list of records or "blocks," which are each, in turn, linked to the previous block and secured using cryptography.[8] This chain of records can be distributed to, or managed by, a peer-to-peer network, hence the often-used-term "distributed ledger."[9] Each block includes a timestamp, a unique hash[10], and transaction data for that block, as well as the entire history of the chain. All of this information. All of these characteristics together allows users of the blockchain to be sure that any block in the chain cannot be retroactively altered, which allows for the facilitation of secure online transactions without the need for banks, payment processors or governments. The security, payment processing, and account tracking and maintenance functions traditionally performed by banks or processors are automated in a distributed and decentralized blockchain environment.

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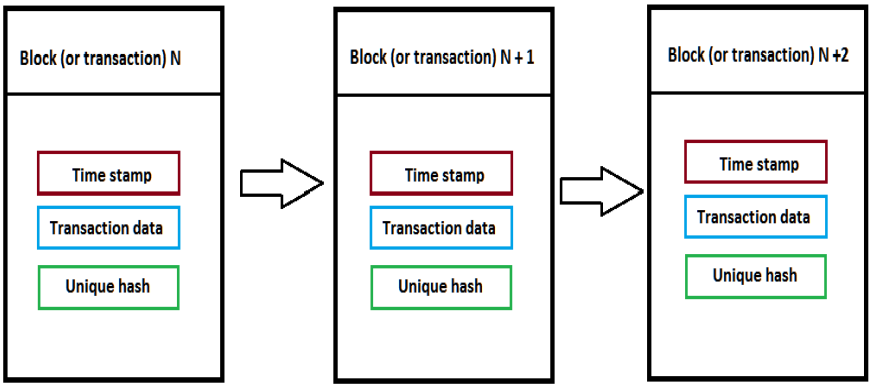
[7] *See* Satoshi Nakamoto, *Bitcoin: A Peer-to-Peer Electronic Cash System*, BITCOIN, https://bitcoin.org/bitcoin.pdf (last visited Apr. 2018).

[8] *See The Great Chain of Being Sure About Things*, THE ECONOMIST (Oct. 31, 2015), https://www.economist.com/news/briefing/21677228-technology-behind-bitcoin-lets-people-who-do-not-know-or-trust-each-other-build-dependable; *Introduction to Smart Contracts*, SOLIDITY, http://solidity.readthedocs.io/en/v0.4.21/introduction-to-smart-contracts.html.

[9] *See*, *e.g.*, *Blockchain & Distributed Ledger Technology (DLT)*, THE WORLD BANK (Apr. 12, 2018), http://www.worldbank.org/en/topic/financialsector/brief/blockchain-dlt.

[10] A hash, or hash function, is a way of mapping any data of any arbitrary size to a number or value (the "hash") of a fixed size. Hash functions are valuable in quickly and easily assigning unique values to each blockchain while preventing reverse-engineering of the data that was used to generate the hash.



Blockchain is generally thought to have the following characteristics:[11]

- *Consensus*–all blocks in a chain must agree on a transaction's validity.
- *Provenance*–participants in the blockchain network can see where a block originated as well as ownership over time.
- *Immutability*–no one can edit a block (or transaction) after it is added to the ledger.
- *Finality*–a single shared ledger provides a singular, trusted source of ownership and transaction history.
- *Decentralization*–the blockchain "ledger" is distributed to many nodes (or users of the blockchain), so the failure of some nodes, or failure of the network is not fatal.

2. Types of Blockchain

Today, there are three high-level classes of blockchain. Understanding the differences between them is critical to understanding the potential varieties of smart contracts across industries.

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[11] *See* Ian J. Mitchell, *Making Blockchain Real for Business,* IBM (2016), https://www.ibm.com/systems/data/flash/it/technicalday/pdf/Making%20blockchain%20real%20for%20business.pdf.

- **Public Blockchains**—The most common type of blockchain is public blockchain.[12] Public blockchain is a blockchain that anyone can read, anyone can send transactions to, and for which anyone can participate in the validation process (see above).[13] Public blockchains are generally considered to be fully decentralized.[14] Bitcoin is a public blockchain.[15]

- **Consortium Blockchains**—Consortium blockchains are validated through a pre-selected and specific set of nodes that determine whether a block is verified.[16] So, for example, a specific subset of the nodes on the chain could validate each transaction (as opposed to public blockchains, in which anyone in the world can participate in validation). Consortium blockchains have potential applicability in industries controlled by entrenched gatekeepers, such as the financial industry, and in circumstances in which the event triggering confirmation of transaction completion varies from transaction-to-transaction. Consortium blockchains are usually described as "partially decentralized."[17]

- **Private Blockchains**—The final type of blockchain, a private blockchain, is one in which transaction execution permissions are controlled by and central to one entity or organization.[18] "Read" permissions for the blockchain can be either public or private, depending on the application.[19] Private blockchains, which are essentially just a new implementation of a traditional private database, which

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[12] Praveen Jayachandran, *The Difference Between Public and Private Blockchain*, IBM (May 31, 2017), https://www.ibm.com/blogs/blockchain/2017/05/the-difference-between-public-and-private-blockchain/.

[13] *See* Vitalik Buterin, *On Public and Private Blockchains*, ETHEREUM BLOG (Aug. 7, 2015), https://blog.ethereum.org/2015/08/07/on-public-and-private-blockchains/.

[14] *Id.*

[15] *See* Praveen Jayachandran, *supra* note 12.

[16] Vitalik Buterin, *supra* note 13.

[17] *Id*.

[18] *Id*.

[19] Praveen Jayachandran, *supra* note 12; Vitalik Buterin, *supra* note13.

might be used in one-off smart contracts, or for internal recordkeeping within a company or trade organization.[20]

To summarize, blockchain allows two or more parties anywhere in the world to enter into a transaction directly with each other while being relatively sure that the transaction is secure, authentic, and unalterable. This transaction can be done whether or not the parties know each other's true identity and without any third- party facilitation or mediation, and these parties can be relatively sure that the transaction is secure, authentic, and unalterable.

B. What is a smart contract?

To understand smart contracts, we must first understand what makes a contract "smart," what makes an instrument executed by two or more parties a "contract," and what it means for obligations under a contract to self-execute.

1. "Smart"

At their base, smart contracts are self-enforcing agreements that exchange promises or consideration between parties based on a transparent set of rules using predefined inputs. Smart contracts' use of distributed ledger functionality together with automated contractual triggers ensures that transactions are completed in a secure and accurate manner, reducing the need for complex regulation or oversight.[21] There are many misconceptions about what makes a contract "smart," which this Section attempts to clarify.[22]

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[20] *See* Justin O'Connell, *What Are the Use Cases for Private Blockchains? The Experts Weigh In*, BITCOIN MAGAZINE (Jun. 20, 2016), https://bitcoinmagazine.com/articles/what-are-the-use-cases-for-private-blockchains-the-experts-weigh-in-1466440884/.

[21] It is important to remember smart contracts do not require blockchain technology to work. A smart contract could, in theory, be implemented any number of ways, and could, for example, be tied to a credit card or bank payment system.

[22] *See Ethereum: The Ultimate Smart Contract and Decentralized Application Platform*, http://web.archive.org/web/20131228111141/http://

Nick Szabo, who is often credited with coming up with the idea of a smart contract, describes the smart contract as "a set of promises, specified in digital form, including protocols within which the parties perform on those promises."[23] In other words, a smart contract is a legal contract that is represented and executed, at least in part, by automated software. Pieces of code, (sometimes referred to as "software agents")[24] perform certain tasks when pre-defined and mutually agreed conditions embedded in the smart contract are met.

A smart contract, however, is not actually very "smart." Smart contracts do not (at least, as of the date of this Article) include artificial intelligence, in that a smart contract does not learn from its actions, modify its behavior to match what is appropriate for the circumstances, understand concepts commonly found in traditional contracts such as materiality or knowledge, adapt to changing environments, or learn from experience.[25] Although smart contracts can respond to variable contingencies, they cannot (as of the date of this Article) "smartly" implement or change their behavior based on unpredicted circumstances. In fact, it is just the opposite. Smart contracts are purposefully designed to be inflexible. [26]

2. Contract

At the risk of stating the obvious, a smart contract must actually

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vbuterin.com/ethereum.html (last visited Apr. 15, 2018).

[23] Nick Szabo, *supra* note 2.

[24] *Smart Contracts and Distributed Ledger–A Legal Perspective*, ISDA (Aug. 2017), https://www.isda.org/a/6EKDE/smart.

[25] *See* POOLE, MACKWORTH & GOEBEL, COMPUTATIONAL INTELLIGENCE: A LOGICAL APPROACH, 1 (1998).

[26] To clarify, a contract is not "smart" merely because it is executed or displayed electronically or via a software platform. Contracts executed electronically by "e-signature," or negotiated or developed via automated software negotiating tools are not "smart" contracts by virtue of their digital execution or origination. The key factor in deciding whether a contract is "smart" is whether or not the contract is automated. *See* Clack, C., Bakshi, V. & Braine, L., *Smart Contract Templates: Foundations, Design Landscape and Research Directions* (Aug. 3, 2016, revised Mar. 15, 2017), http://www.resnovae.org.uk/fccsuclacuk/images/article/sct2016.pdf.

be a contract.[27] That is to say, it must meet the characteristics of being a legally enforceable exchange of promises. Since countless others before us have written at length regarding the defining attributes of an enforceable contract, we will be brief. Like any other contract, to be legally enforceable, a smart contract must have the following attributes:[28]

- offer;
- acceptance;
- consideration;
- intent (or "mutuality of obligation");
- each party must have capacity to contract; and
- the agreement must be of lawful subject matter.

We discuss the formation of a contract in Part II below. The rest of this Part assumes that a smart contract has been formed in compliance with the applicable legal regime.

3. Self-execution

As noted above, a smart contract is premised on self-execution; i.e., one or more aspects of the contract's execution are automatic. Smart contracts use blockchain to ensure that once the parties

[27] It is important to note that many in the smart contracts community would disagree with this statement. Some in the community would argue that smart contracts are *ultra vires*, and that one does not need to ask the question of whether or not smart contracts are legally enforceable contracts under the traditional, legal definition of "contract," because, from a smart contract purist's point of view, questioning enforceability and enforcement is irrelevant since the execution of a smart contract happens automatically. Automatic execution would seemingly eliminate the need for enforcement (or analysis of whether a smart contract might be enforceable). We think that, while this sentiment is admirable, it is unrealistic, because it is inevitable that disputes over smart contract enforcement, formation and other issues relating to transactions carried out via smart contracts that cannot be resolved via the smart contracts code will end up in court or arbitration. Therefore, this Article is written with the point of view that it is necessary and appropriate to analyze the enforceability of smart contracts from a traditional perspective.

[28] *See generally* Restatement (Second) of Contracts §§ 12–95, 178–198 (Am. Law Inst. 1979).

execute the contract, the transactions contemplated by that contract are accurate and cannot be avoided by any party without the other parties' consent.[29] For a technology to automatically determine whether a party has performed, or if a condition has been met, there must be some clear-cut input to the code underlying that technology (that is the "smart contract"), via a connection, usually via data feed, to the world outside the bounds of the blockchain allowing the contract to determine "if X, then Y."[30]

If/then statements are one of the most basic building blocks of any computer program and easily portable to smart contract applications. The "X" in an "if X/then Y" statement could be a stock reaching a certain value, and the Y could be a payout from one party to the other. The X could be a good arriving at a location, and the Y could be a lien being automatically released. The X could be a third party providing a verified e-signature, and the Y could be an escrow being released. The possibilities are endless.[31]

Today, most smart contracts: (a) are relatively simple; (b) do not govern complex contractual relationships; and (c) are comprised of relatively basic if/then statements on top of a blockchain platform (such as Ethereum).[32] If/then statements often tie the release of funds (the "then") to the basic fulfillment of an "if" condition.[33] Going forward, however, smart contracts may not be so simple, and prospective parties will not need to understand programming or blockchain to use one. In fact, the future smart contract could look very much like a traditional paper contract, except that certain parts

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[29] *See* discussion *supra* Part I.A.1.

[30] *See Oracles*, BLOCKCHAINHUB, https://blockchainhub.net/blockchain-oracles/ (last visited Apr. 15 2018).

[31] *See infra* Part III.

[32] However, the Ethereum platform and blockchain is built on a Turing complete, or near-Turing complete language, which means that it is technically feasible for even Ethereum-based smart contract's to include complex, advanced functionality that goes well beyond the simple if/then statements described in this section. *See* Kyle Wang, *Ethereum: Turing Completeness and Rich Statefulness Explained*, MEDIUM CORPORATION (July 9, 2017), https://hackernoon.com/ethereum-turing-completeness-and-rich-statefulness-explained-e650db7fc1fb. The authors expect smart contract complexity to evolve quickly over time.

[33] *See Blockchain App Platform*, ETHEREUM, https://www.ethereum.org/ (last visited Apr. 15, 2018).

of that contract (e.g., performance obligations) will be automated.

Some smart contract terms may be written in plain, semantic English (or whatever conversational language the parties choose to use), but other provisions of that same agreement will be self-executing.[34] Indemnity payouts, insurance triggers, and various other provisions of the contract could be automated and self-fulfilling, while other provisions remain rooted in the "real world" (i.e., outside of the blockchain). It is important to keep in mind that, for each if/then trigger of a smart contract, that trigger must be tied to a definitive real-world, but automatically (and likely electronically) verifiable input. If a human has to decide whether a condition is met and trigger a result baked into an automated electronic contract, that contract is not truly smart, because, like with all contracts, reasonable (human) minds can differ. As smart contract technology evolves, so too will the breadth of the real-world inputs, the if/then triggers, and commercial applications.

II. NEITHER ABOVE NOR BELOW THE LAW: LEGAL ISSUES FACING ADOPTION OF SMART CONTRACTS

Part II provides an overview of legal issues relating to the use of smart contracts. At the date of this Article, there have been no court cases–at least not in the United States–providing direct guidance on the enforceability of smart contracts, nor is there a fully developed smart contract market with agreed-upon industry-wide standard practices (which often inform legal results).[35] Without any smart-contract specific guidance, smart contracts are best analyzed under traditional contract principles.

Below, we describe some of the key legal issues facing the formation, execution, and enforcement of fully self-executing smart contracts.[36]

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[34] *See, e.g.*, Ian Grigg, *On the Intersection of Ricardian and Smart Contracts*, IANG.ORG (Feb. 2015), http://iang.org/papers/intersection_ricardian_smart.html.

[35] *See infra* Part IV.

[36] This is as opposed to automated contracts that are ancillary to negotiated traditional contract terms. If any paper is involved, then almost all of the legal risks associated with a smart contract can be addressed during negotiations and drafting.

A. Formation

As briefly discussed in Part I.B.2, any contract analysis must begin by establishing whether a contract exists at all. At the most fundamental level, contract formation requires offer and acceptance.[37] Offer and acceptance signify both parties have accepted the terms of the agreement.

Historically, acceptance was indicated by conduct or a wet ink signature.[38] However, in recent years, contract formation has occurred more and more frequently via electronic means. Since Congress enacted the Electronic Signatures in Global and National Commerce Act ("E-Sign Act") in 2000,[39] which gives legal effect to electronic signatures, digital acceptance through tools like DocuSign has become routine.

Additionally, many companies (particularly, consumer-facing companies) rely on alternative means of obtaining acceptance to contracts. For example, users of online services are often presented with a box that they must check in order to indicate assent to standard, non-negotiable terms and conditions.[40] These contracts, and others purporting to be formed by signifying acceptance through action (e.g., "By clicking "register," you agree to the Terms of Use) have been deemed enforceable when the user has been provided "reasonably conspicuous notice" of contract terms and "manifests assent" to those terms.[41] Notice can be provided by means of a conspicuous hyperlink with language that calls attention to the

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[37] *See* discussion *supra* Part I.B.2.

[38] While contracts may be formed without signatures, a signature authenticates the parties who are responsible for performance under the contract. Sophisticated contracting parties typically require signatures. Some contracts are required by law to be authenticated by the parties. *See, e.g.*, U.C.C. § 2-201.

[39] 15 U.S.C. § 96 (2000).

[40] Non-negotiable consumer contracts are also known as "contracts of adhesion."

[41] Specht v. Netscape Communications Corp., 306 F. 3d 17, 33 (2d Cir. 2002). *Cf.* Nguyen v. Barnes & Noble, 763 F. d 1171 (9th Cir. 2014) (suggesting that a contract may be enforceable if a user had notice of, *or* manifested assent to the Terms. However, the cases cited in *Nguyen* suggest that notice is always required. It is the manifestations of assent that may be implied, depending on the circumstances of the notice.).

action being requested: "By checking the box, you hereby agree to the Terms of Service."

Insofar as smart contracts are contracts (i.e., legal instruments), they will be subject to the same level of scrutiny as traditional contracts when faced with formation disputes. All parties will need notice of the terms of the contract and to undertake an action that indicates affirmative assent to those terms. In a smart contract context, notifying users of the terms of the agreement may involve presenting them with the series of if/then statements that comprise the code base and subsequently obtaining consent through a digital function, such as a check-box or "execute" button that would need to be clicked, with the clicks logged somewhere as evidence in the event of a dispute. So long as the manifestation of assent is automated, and the code is not authorized to begin performance until all parties have indicated assent, formation should not be a significant legal issue for smart contracts. Since it is an established principle that e-signatures, check-boxes, and other digital methods of contract execution can be valid and binding, it is likely courts will make the same determination regarding smart contracts entered into via the same or similar digital or online processes.

B. Assuming the Risk: Risk Allocation in an Automated World

Traditional contracts typically involve a number of provisions that shift risk between parties, such as representations and warranties and indemnification obligations. These provisions determine which party is on the hook for liability associated with certain events. For example, in the software-as-a-service context, the service provider often indemnifies the user for any third-party claims of infringement arising from the user's use of the platform.[42] Similarly, a data licensor may offer to indemnify a licensee for any claims alleging the licensor did not obtain any required consents to transfer the data. Many risk-shifting provisions found in traditional contracts can be obviated in smart contracts. For example, in a traditional contract, one party may negotiate for the other party to

[42] *See, e.g.*, *AWS Customer Agreement*, Section 9, https://aws.amazon.com/agreement; *see also* Daniel Akst, *Those Crazy Indemnity Forms We All Sign* (Dec. 8, 2012), https://www.nytimes.com/2012/12/09/opinion/sunday/those-crazy-indemnity-forms-we-all-sign.html.

carry certain insurance levels and certify as to its solvency. However, in smart contracts, that type of obligation may not be necessary, because a party has more certainty the other party will pay or perform via the contract's automated functionality. A smart contract could be built to take regular readings of a party's financial health through plug-ins to bank accounts or credit scores and then suspend activity when balances or scores fall below a certain level.

C. Indemnification

Indemnification is a bargained-for shield against certain losses: if a proscribed "bad thing" happens to one party, the other party will cover the first party's losses.[43] These "bad things" could be a lawsuit, a data breach, or property damage. Building full indemnification provisions into a smart contract is likely unworkable in the near future because the variables and flexibility that are often included in that type of provision would be difficult to translate into smart contract code. For example, an indemnity provision could be triggered by the filing of a lawsuit against a party. That can be verified by the blockchain through a Pacer (the public court records system) alert.[44] However, the costs that a party would cover – litigation expenses, attorneys' fees, and so forth will vary based on the claim and the extent of remedies pursued. Those costs therefore cannot be practically listed within the blockchain. Further, it could be difficult for blockchain or smart contracts to correctly identify that the lawsuit filed was related to the contract and subject to the indemnity provision. Additionally, some indemnity obligations do not get triggered until there is a final non-appealable judgment - it is unlikely a contract will know when a party has exhausted all of its appeals.

For users to obtain any meaningful indemnity, they will have to do some negotiation outside of the blockchain. That could be easily accomplished in a private blockchain, where users know each other. However, in a public blockchain, it is unlikely that anonymous users would sit at a table to negotiate indemnities. As an alternative, users

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[43] PETER C QUITTMEYER ET AL., COMPUTER SOFTWARE AGREEMENTS: FORMS AND COMMENTARY § 13:34 (2002).

[44] *See* PACER, https://www.pacer.gov/announcements/general/rssnews.html (last visited May 8, 2018).

could explore insurance policies to provide the coverage they might otherwise get under an indemnity. Or, each party could contribute to an escrow account to cover claims made against other parties.

D. Flexibility

Smart contracts, by their nature, are not intended, or desired, to be flexible. Rather, the goal - immutability and measurability - is the very opposite, unlike traditional contracts, which commonly build in mechanisms for amendments, modifications, or varying standards of performance. Each of these mechanisms assists with risk allocation in different ways. For example, a party may want to be judged by "commercially reasonable efforts," rather than an absolute standard of performance. Similarly, a party may only want certain actions to occur if they have *materially* breached the agreement.

Smart contracts are built on the notion there will not be any modifications after contract finalization. As a result, if or when circumstances relevant to the smart contract change, a whole new contract would need to be written.[45] Similarly, traditional contracts often include concepts of knowledge, materiality, and varying effort levels, all of which are subjective measurements. These standards are not easily translated into a self-executing objective performance mechanism. As a result, parties to a smart contract must get comfortable without these unqualified standards.

E. Enforcement

Traditionally, contracting parties build dispute resolution and enforcement mechanisms into a contract—jurisdiction, venue, alternative dispute resolution mechanisms, etc.[46] In a smart contract, the need to enforce should be reduced, given performance is

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[45] One author suggests that a smart contract's code read off of a natural language version of the contract that can be easily updated and translated into the code to address this issue. *See* Reggie O'Shields, *Smart Contracts: Legal Agreements for the Blockchain*, 21 N.C. BANKING INST. 177 (2017).

[46] *See* LEXOLOGY, *Dispute Resolution Clauses and the Importance of Drafting*, (May 14, 2010) https://www.lexology.com/library/detail.aspx?g=0ffe4bc1-5c70-4bca-a58d-420f7ea748e8.

automated. However, situations could arise where a party seeks to enforce the contract against the other. For example, in a smart contract that involves automated payment mechanics, if one party closes the bank account from which the payments are drawn, and the other party's obligations continue to be executed, then that party may seek to enforce the payment obligations.

A primary concept of contract enforcement is that the party seeking to enforce the contract knows who the other party is. In a private blockchain, knowledge of the identity of one's counterparty will likely be the norm. However, in a public blockchain, the parties may not necessarily know each other beyond usernames. To mitigate the risk of having to track a party down in real life mid-dispute, the parties could build automated third-party verification tools into a smart contract, such as a background check on the other party. The results of the check could be made available to each party so there is full transparency as to who the parties are. This mechanism would also allow location to be recorded such that a lawsuit could actually be served. Note, though, that adding identity verification may discourage some parties from entering into smart contracts, as one of the primary features of and reasons to use blockchain - at least public blockchain – is to put trust in the system and not the individual. [47] As a result, smart contract parties may prefer to default to anonymous, electronic arbitration.

Even if the counterparty's identity can be determined, his or her location would still need to be known for purposes of determining jurisdiction and effecting personal service in the event of a lawsuit.[48] One way users can smartly contract around the issues with physical presence is to include automatic arbitration in the smart contract that provides for anonymous, online dispute resolution in the case of an issue.[49]

If the counterparty cannot be found, a user may resort to bringing claims against the only truly known entity in the picture – the blockchain or smart contract platform provider. However, a user's recourse against that entity may be limited by the terms of its

[47] *See* Rachel Botsman, *How the Blockchain is Redefining Trust*, WIRED (Dec. 27, 2017) https://www.wired.com/story/how-the-blockchain-is-redefining-trust/.

[48] *See, e.g.*, Fed. R. Civ.P. 4(c).

[49] *See infra* Part IV.

contract with the provider. For example, Ethereum provides a number of blockchain applications, including a wallet. The software for the wallet comes pursuant to license agreements for the various software components included in the wallet, which reads in part:

> EXCEPT WHEN OTHERWISE STATED IN WRITING THE COPYRIGHT HOLDERS AND/OR OTHER PARTIES PROVIDE THE PROGRAM "AS IS" WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THE ENTIRE RISK AS TO THE QUALITY AND PERFORMANCE OF THE PROGRAM IS WITH YOU. HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM, OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.[50]

This license unambiguously attempts to disclaim all liability arising out of the use of the software, leaving users with little recourse against Ethereum. Further, some blockchain platforms are open sourced or in the public domain, resulting in no single party to go after.[51]

F. State Laws

In addition to issues that may arise out of general contracting

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[50] "LICENSE" available when a download of Ethereum Wallet is initiated (last accessed May 18, 2018).

[51] For examples of open source blockchain platforms, *see* Toshendra Sharma, *List of Best Open Source Blockchain Platforms*, BLOCKCHAIN COUNCIL (Aug. 29, 2017), https://www.blockchain-council.org/blockchain/list-of-best-open-source-blockchain-platforms/.

principles, there is a risk of inconsistent laws developing. For example, in 2017, Nevada and Arizona enacted laws applicable to smart contracts.[52] These statutes, among other things:

- Clarify that records that are solely in electronic form will be not deemed unenforceable solely by virtue of their media, and further state that where records are legally required to be in writing, an "electronic record" satisfies the law.[53] "Electronic record" is defined as a "record created, generated, sent, communicated, received or stored by electronic means"[54] and is intended to include blockchain transactions.[55]

- Authorize the use of smart contracts.[56] For example, the Arizona statute states:

> A. In any automated transaction, the parties may form a contract by the interaction of:
>
> (1) Electronic agents of the parties, even if no individual was aware of or reviewed the electronic agents' actions or the resulting terms and agreements.
>
> (2) An electronic agent and an individual who acts on the individual's own behalf or for another person, including by an interaction in which the individual performs actions that the individual may refuse to perform and in which the individual knows or has reason to know will cause the electronic agent to complete the transaction or performance.

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[52] Nev. Rev. Stat. § 719 (2017); Ariz. Rev. Stat. § 44–7001 (2016).

[53] Nev. Rev. Stat. § 719.090 (2017); Ariz. Rev. Stat. § 44–7007(C) (2016).

[54] Nev. Rev. Stat. § 719.090 (2017); Ariz. Rev. Stat. § 44–7002(7) (2016).

[55] LEGISLATIVE HISTORY OF SB 398–2017, https://www.leg.state.nv.us/Division/Research/Library/LegHistory/LHs/2017/SB398,2017.pdf.

[56] Nev. Rev. Stat. § 719.310 (2017); Ariz. Rev. Stat. § 44–7014 (2016).

> (B) In addition to subsection A, paragraphs 1 and 2, the terms of any contract are determined by the substantive law that applies to that contract.[57]

In these states, then, smart contracting has been sanctioned. However, until all fifty states have enacted similar legislation, there remains a risk that a contract may be enforceable in one state and not in another. A conservative smart contractor could insist on contracting with parties only in states where smart contracts are recognized, using IP address look-up tools to verify a party's location.

G. Other Considerations

1. Third party intrusion

A party could also face risk if there is a flaw in the code that generates the contract. In 2017, hackers stole $30 million worth of Ether, the cryptocurrency Ethereum issues.[58] Hackers accomplished this heist by discovering a vulnerability in the blockchain code, not the blockchain platform or conduct by any particular user.[59] If there were similar vulnerabilities in a smart contract, the parties would have a difficult time obtaining recourse against the hackers.

First, the hackers would not have privity with the contracting parties, since they are (presumably) not part of the blockchain. Therefore, there would be no contract claim against the hackers.[60] At best, there could be claims in tort (e.g., conversion and tortious interference), as well as criminal claims, each of which would

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[57] Ariz. Rev. Stat. § 44–7014 (2016).

[58] *See* Lily Katz and Camila Russo, *Crypto Wallet Company Faces More Problems After July Hack*, BLOOMBERG TECHNOLOGY (Nov. 7, 2017), https://www.bloomberg.com/news/articles/2017-11-07/cryptocurrency-wallet-firm-faces-more-problems-after-july-hack.

[59] *See* Haseeb Qureshi, *A Hacker Stole $31M of Ether—How it Happened, and What it Means For Ethereum*, MEDIUM CORPORATION (July 20, 2017), https://medium.freecodecamp.org/a-hacker-stole-31m-of-ether-how-it-happened-and-what-it-means-for-ethereum-9e5dc29e33ce.

[60] Note, however, that the hackers could still be sued under a variety of other legal theories, such as conversion and, depending on the facts, tortious interference with a contractual relationship.

require catching the hacker in the first place. If the parties had been savvy enough to obtain promises from the code developer as to the security of the code, then the parties could seek damages from the developer of the code itself for breach of contract. Alternatively, the aggrieved party could pursue a theory of negligence, which would be a tenuous theory of recovery at best and would depend on arguing there is a duty that runs from the developer to the user.

This is in contrast to the offline world, where, if a hacker hacked an individual's bank account, that individual could rely on his or her contractual and fiduciary relationship with the bank (as well as potential protection through the Federal Deposit Insurance Corporation or equivalent institutions outside the U.S.) to make him or her whole. These protections do not exist in the smart contract realm.[61] There is no fiduciary duty between a software platform and its users. [62] And, as noted above, the developers of the platform may not even be identifiable if the platform is open sourced.

One way parties are addressing these risks is to engage auditing firms to confirm the code is written to specification.[63] To the extent a lawyer is involved in the "drafting" of a smart contract and that lawyer is not also fluent in code, the lawyer should engage an auditing firm to avoid potential malpractice claims.

2. Statute of frauds

Certain contracts[64] are required to be in writing under the Uniform Commercial Code principle known as the Statute of

[61] Note that the users would likely have a claim against the hackers for conversion, if they are able to figure out who they are.

[62] Definition of fiduciary: https://legaldictionary.net/fiduciary/ (describing the duty of care that characterizes fiduciary relationships)

[63] *See, e.g.*, *Be Confident in Your Smart Contract*, SOLIDIFIED, https://solidified.io/ (last visited Apr. 15, 2015). Using a platform like Solidified necessitates disclosure of the smart contract to third parties, and so to the extent the smart contract is a private one, the parties should understand that they are both waiving confidentiality.

[64] These include contracts for marriage, contracts for the sale of goods where the value is over $500, contracts that cannot be fully performed within one year, and contracts for transfers of land.

Frauds.[65] The Arizona and Nevada statutes make clear smart contracts are to be considered "writings," but other states may take different approaches. Until there is a unified approach to whether smart contracts constitute writings, parties seeking to enter into contracts governed by the Statute of Frauds should proceed with caution.

3. Regulatory concerns and compliance with laws

Smart contracts have arisen in highly regulated fields, such as banking and data transfers.[66] Developers coding smart contracts should be cognizant of applicable regulations, such as the European Union's "right to be forgotten" principles for data transfer, and the United States' "know your customer" regulations in the banking and anti-money laundering contexts.[67]

Additionally, there are laws about who a person may contract with.[68] For example, Americans cannot enter into contracts with ISIS or any other terrorist organizations.[69] In a public blockchain, it is conceivable that a user could be contracting, knowingly or unknowingly, with an entity that is prohibited by law, and users should be aware of those risks.

4. Ethical issues in the practice of law

Lastly, it is illegal in the United States to practice law without a license. In Washington State, for example, anyone who is not a lawyer is prohibited from practicing law or holding him or herself out as being entitled to practice law.[70] Washington Court Rules define practicing law as "selection, drafting, or completion of legal

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[65] U.C.C. §2-201.

[66] See *infra*, Part III.D.

[67] *See* Google Spain SL, Google Inc. v Agencia Española de Protección de Datos, Mario Costeja González (2014), C-131/12 (holding that European Union privacy law provided individuals with a "right to be forgotten"); Bank Secrecy Act of 1970, Pub L. 91-508.

[68] In addition, parties should be cognizant of contracting with minors, who may void most contracts until the age of eighteen.

[69] *See, e.g.*, Executive Order 13224, 66 Fed. Reg. 49079 (Sept. 25, 2001).

[70] Wash. Rev. Code § 2.48.180 (2016).

documents or agreements which affect the legal rights of an entity or person(s)."[71]

Similarly, Arizona's court rules, which have remained unchanged since the passage of its blockchain statute, note the practice of law includes "preparing any document in any medium intended to affect or secure legal rights for a specific person."[72] Insofar as smart contracts have been given legal effect, then developers coding smart contracts without attorney supervision (and particularly those that hold themselves out as specializing in smart contracts) could be at risk under state laws regulating the practice of law.[73]

III. INDUSTRY APPLICATION/CURRENT STATE OF SMART CONTRACTS

Several industries are already working on developing a framework for a smart contracts ecosystem.[74] These industries often share baseline characteristics, such as:

- An established regulatory standard for conducting transactions, which often provides baseline rules on which one can base smart contract "triggers." For example, real estate has established norms for collecting money upon the acceptance of an offer and holding the money in escrow for a set period of time before releasing the funds upon closing (i.e. confirmation of a set of conditions).[75]

- A lengthy and/or burdensome contracting process for relatively simple functions. For example, contracts to buy or sell futures in a stock or commodity often start with the terms of a financial intermediary, who then has to find a buyer and a seller willing to accept the terms as-is or negotiate the

[71] Wash. St. Ct. R. 24.

[72] Ariz. Sup. Ct. R. 31.

[73] One company, Clause, seeks to find a middle ground. Clause enables contracts (including paper contracts) to be operationalized in a dynamic, automated way and is partnering with law firms to obtain appropriate legal oversight.

[74] *See* discussion *infra* Part III.D.

[75] *Home Buying in Six Steps*, NATIONAL ASSOCIATION OF REALTORS (Sept. 22, 2014), https://www.nar.realtor/articles/home-buying-in-six-steps.

terms with a buyer and seller in parallel.

- A multitude of stakeholders. For example, in an oil production environment, there is generally a pumper, a dispatcher, a transporter, a treatment facility, a producer, a buyer, and a guarantor (often a bank or other private insurer).

An industry need not have all, or even one, of the above characteristics to benefit from smart contracts. Each of the above attributes are merely economic drivers that may push early adopters to begin using smart contracts before the technology becomes widely established.

The adoption of smart contract technology has been encouraged by the governmental sector. State governments have begun legislating the use of smart contracts, starting with the recognition that smart contracts can be legally enforced.[76] Specifically, as described above, Arizona recently passed a statute that does not strip a contract of its enforceability solely because it is a smart contract, encouraging technology-sector development in the state.[77] Additionally, Vermont passed a statute that validates the use of blockchain records as records of business.[78]

While early adoption of smart contracts appears to be driven by sectors with regulatory predictability, the industries that stand to benefit the most from the use of smart contracts tend to share certain characteristics. Three common shared characteristics of these industries are: (a) mutating contingencies; (b) measurable milestones; and (c) multiple stakeholders.

A. Mutating Contingencies

A contract having a "mutating contingency" is the idea that the potential outcomes under a contract are not binary, but instead

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[76] *See* Nathan J. Fish, *Arizona Edges to Front of States Eyeing Blockchain Technology*, ARIZONA DAILY STAR (Aug. 18, 2017), http://tucson.com/business/arizona-edges-to-front-of-states-eyeing-blockchain-technology/article_be68d42f-ddb5-5650-9a04-97915b22bf24.html.

[77] *Id.*

[78] Vt. Stat. tit. 12 § 1913 (2016).

plenary. In simple terms, having mutating contingencies means there are multiple ways performance may be satisfied under a contract, either based on the choices of a party or external circumstances (such as availability of a component or service or changing market pricing). The value, and length, of a written contract is directly correlated to the number of contingencies. For example, a simple in-person sale of an apple for $1 won't normally involve a contract, because the cost in time of preparing a contract for the sale outweighs the worth of the transaction. In contrast, a sale of hundreds of widgets might have to account for partial deliveries, returns of unsatisfactory widgets, and servicing of widgets after delivery. Hence, the need for a written contract that documents a decision tree of outcomes. The presence of mutating contingencies drives adoption of smart contracts because as long as the inputs can be tied directly to "if/then" statements, a smart contract can automatically facilitate every potential scenario, rather than requiring huge amounts of ink or a multitude of amendments. For example, if only 50 widgets are logged in a system as being delivered when the purchase order called for 100, then payment could easily be automatically reduced so that the buyer only pays for fifty widgets. The more different (yet quantifiable) "if/then" scenarios a business operates pursuant to, the more likely it is to benefit from a smart contract that can automate all of the different contingencies.

B. Measurable Milestones

Another characteristic of industries that could benefit from smart contracts is measurable milestones, i.e., conditions or performance that can be objectively quantified. Unlike mutating contingencies, measurable milestones are tantamount to the current smart contracting practice of relying upon input from outside sources (such as an "oracle").[79] One of the basic requirements of a blockchain contract is that the parties have to agree in advance to performance conditions, which parties are more likely to do if they

[79] *See Oracles*, BLOCKCHAINHUB, https://blockchainhub.net/blockchain-oracles/ (last visited Apr. 15, 2018).

view the conditions as objectively measurable.[80]

For example, the sale of a commodity (e.g., gold) can be easily verified based on a weight and an evaluation of the substance. In contrast, an individual who hires an artist to create a painting is unlikely to agree to make payment upon the delivery of any 10x10 canvas with oil paint. Rather, that individual will want to decide whether it lives up to his or her standards and the specifications provided, which are more than just a measure of the materials involved, and thus is unlikely to agree to an automated verification of worth. As previously discussed, the "if/then" statements that make up the content of a smart contract must be capable of objective measurement.[81]

C. Multiple Stakeholders

Finally, many industries that would benefit from smart contracts, including real estate and banking have numerous stakeholders for typical transactions in those industries.[82] In other words, it is commonplace for a contract to have more than two signatories, or third parties that are necessary in order to measure performance of the contracting parties.

Traditional contracts often handle multiple stakeholders using reams of paper, lengthy negotiations, and drawn out negotiations to address contingencies among the many parties. For example, in the oil production scenario (where there is often a pumper, a dispatcher, a transporter, a treatment facility, a producer, a buyer, and a guarantor), the supply chain is complex. The pumper extracts the commodity, the volume is verified (often by a third party), the transporter finds transport for the volume and confirms timelines for delivery, and the buyer confirms delivery on-time and at the stated volume to the guarantor. A smart contract would enable all parties to share an interface that both allows to adjustment of deliverables and timelines (with set contingencies for adjustments) and allows third-parties to input confirmations in a way that is immediately

[80] *See* Liz Louw, *Blockchain Smart Contracts Explained*, BITSTOCKS (Jan. 12, 2018), https://www.bitstocks.com/blog/blockchain-smart-contracts-explained.

[81] *See* discussion *supra* Part I.B.3.

[82] *See* discussion *infra* Part IV.D.

verified for all other stakeholders. The immutability of blockchain enables each party to rely on the verification that performance is complete.

D. Current Adoption

Three industries having the potential to benefit significantly from smart contract adoption are: (a) banking; (b) music licensing; and (c) real estate. Below we discuss how smart contracts could improve relationships and transactions in each industry.

1. Banking

Given the origins of blockchain and the quick, widespread adoption of cryptocurrency, such as bitcoin, it is no surprise that one of the first predicted implementations of smart contracts is in the banking industry.[83] Banking has all the characteristics discussed above, i.e.:

- Mutating Contingencies—Many banking transactions rely on changing price points and dependent values.

- Measurable Milestones—A commodity hitting a specific price point is easily measured and tracked.

- Multiple Stakeholders—Many financial transactions involve at least three parties: a buyer, a seller, and an intermediary such as a bank or investment fund, if not also a separate exchange.[84]

Banking's pre-existing technical infrastructure also lends itself

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[83] *See* Oliver Herzfeld**,** *Smart Contracts May Create Significant Innovative Disruption,* FORBES (Feb. 22, 2016), https://www.forbes.com/sites/oliverherzfeld/2016/02/22/smart-contracts-may-create-significant-innovative-disruption/#49ca6a64396a.

[84] For information on how stock option contracts work, *see How Options Work*, FORBES, (Jan. 1, 2007) https://www.forbes.com/2006/10/18/markets-options_education_center_basic_how_options_work.html#135acc6d3b2f.

to smart contract adoption. For example, high-frequency trading via automated software that trades stocks hundreds of times per day to obtain fractional gains on a high volume of sales requires a technological framework for conducting trades without human intervention for execution of a deal.[85] The only difference between current automated trading technologies and smart contracts is that a contract involves discrete parties (e.g., a buyer and seller) who have decision power, in contrast with an investment fund that is unilaterally executing decisions to benefit itself.

Banks are testing the smart contract waters. On an industry-wide basis, one goal is to use blockchain technology to track corporate borrowers and share fraud detection activity across banks, subject to know your consumer rules and data use regulation.[86] In the past year in India, a consortium led by the State Bank of India ("SBI") known as BankChain has explored different ways to incorporate blockchain technology into bank contracts.[87] In November 2017, SBI announced it would launch its first test of smart contract technology, starting with non-disclosure agreements, but moving into shared fraudulent activity logs.[88] In December, BankChain followed-up by announcing that they plan to launch basic ledger functionality for account tracking and other low-risk contract applications in the next few months.[89]

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[85] *See* Bill Conery, *High Frequency Trading Explained Simply*, FORBES (Apr. 14, 2014), https://www.forbes.com/sites/billconerly/2014/04/14/high-frequency-trading-explained-simply/#592ff73d3da8.

[86] Anand Murali, *Indian Banks Ready to Launch First Blockchain-Based Solution to Map Corporate Borrowers, Spot Fraud*, FACTOR DAILY (Dec. 13, 2017), https://factordaily.com/indian-banks-nbfc-blockchain-technology-bankchain/.

[87] Sujha Sundararajan, *State Bank of India to Beta Test Blockchain Smart Contracts Next Month*, COINDESK (Nov. 20, 2017), https://www.coindesk.com/state-bank-of-india-to-roll-out-smart-contracts-and-blockchain-kyc/.

[88] *SBI to Use Blockchain for Smart Contracts and KYC By Next Month*, THE ECONOMIC TIMES (Nov. 20, 2017), https://economictimes.indiatimes.com/industry/banking/finance/banking/sbi-to-use-blockchain-for-smart-contracts-and-kyc-by-nextmonth/articleshow/61715860.cms.

[89] Shritama Bose, *SBI to Deploy Blockchain in Three Functions in FY19*, FINANCIAL EXPRESS (Feb. 9, 2018), http://www.financialexpress.com/industry/sbi-to-deploy-blockchain-in-three-functions-in-fy19/1058852/.

2. Music

Music also has the hallmarks of a successful smart contract industry. In particular, both licensing and paying for the use of a composition[90] by online music services are easily translatable to smart contract technology.

- Mutating Contingencies—Different outcomes depend on the use of a song and the rights holder of that song.[91] For example, public performances of songs are subject to different royalty schemes than reproductions of songs.[92]

- Measurable Milestones—Uses of songs by digital music platforms can be objectively verified. The number of downloads on iTunes or streams on Spotify are tracked, and can be used to determine royalty payments. [93] Music users have the option to pay royalties that are set by statute, so it is even possible to implement smart contracting for royalty payments without any negotiation over fees. The only requirement for the statutory license is to send a "notice of use" to the copyright owner or the Copyright Office prior to using the composition,[94] and then to issue reports (with payments) detailing usage (which may be issued electronically in many instances).

- Multiple Stakeholders—The music industry has numerous stakeholders, including record labels, music publishers,

[90] There are two copyrights in each song. One is in the underlying composition (i.e., the lyrics and sheet music) and the other is in the sound recording (i.e., the audible rendition of the composition). In this section, we discuss the composition only.

[91] *See Types of Copyright*, BMI, https://www.bmi.com/licensing/entry/types_of_copyrights (last visited May 8, 2018).

[92] *Id.*

[93] *Id.*

[94] The authors do not mean to oversimplify how difficult a process this is for some companies. *See, e.g.*, *Ferrick v. Spotify USA Inc. www.SpotifyPublishingSettement.com*, GARDEN CITY GROUP LLC, http://www.spotifypublishingsettlement.com/ (last visited Apr. 15, 2018).

> songwriters, recording artists, producers and distribution outlets. Given that copyrights are divisible, there may be three or four claimants to a song, each exercising different rights.

If an online music service sends the aforementioned notice of use to the appropriate copyright holder, then the remaining execution of the statutory license could be easily automated. Currently, many online services use intermediaries to help with the administration of the license because of the volume of paperwork involved. If a smart contract were to automate all of that extra work, then both the copyright owners and online services would benefit.

Today, the music industry is already exploring smart contract applications. Companies like Ujo Music are working with creators to automate distribution of recordings (and payments for use), leveraging Ethereum as a platform.[95] Choon recently launched a music streaming service and digital payments ecosystem that uses Ethereum smart contracts to pay musicians directly for streams of their music.[96]

However, critics are still doubtful of the industry's ability to adopt a smart contract system. The music industry is steeped in custom and without buy-in from all of the stakeholders (particularly, the music publishers and performing rights organizations that make money from the licensing of works and control the necessary ownership data for compositions), there is concern that blockchain will never be able to scale to cover the billions of transactions that occur in the music ecosystem.[97]

3. Real estate

Lastly, real estate is an industry that we believe is likely to benefit from smart contracts:

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[95] *Ujo*, UJO MUSIC, https://ujomusic.com/ (last visited Apr. 2018).

[96] *Choon*, CHOON, https://www.choon.co/ (last visited Apr. 15, 2018).

[97] David Gerard, *Attack of The 50 Foot Blockchain: Bitcoin, Blockchain, Ethereum & Smart Contracts*, HYPEBOT.COM, http://www.hypebot.com/hypebot/2017/08/why-you-cant-put-the-music-industry-on-a-blockchain-excerpt.html (last visited Apr. 15 2018).

- Mutating Contingencies—Real transactions inherently involve the possibility of mutating contingencies, including accepting or rejecting an offer, extended or shortened escrow, methods of resolving issues with the property, and the meeting of closing conditions. [98]

- Measurable Milestones—The greatest challenge of a real estate smart contract is the milestones. Often, while closing-conditions are written as exact and predictable, they depend on the acceptability of an alternative or compromise to a buyer or other events reliant on unpredictable human decision making. [99] However, this obstacle may be surmountable given that by the time a house enters an escrow period, both the buyer and seller are likely invested enough to avoid challenging closing unless the problems with the property/transaction are drastic.

- Multiple Stakeholders—A typical real estate transaction has multiple stakeholders, namely the buyer, the seller, the agents of both, the bank, and potentially home inspectors and contractors.

Real estate lends itself to smart contract deployment due to its ability to potentially incrementally adopt smart contracts, starting with simpler transactions, and evolving to transactions with more complexity. For example, as a starting, straightforward application, in a simple land sale, where the buyer and seller contract to sell the land as-is, a smart contract could verify the size and chain-of-title through government records, and execute the closing and money transfer. As a result, the parties would eliminate the need for extensive title searches and brokers.

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[98] *See* Jean Folger, *Contingency Clauses in Home Purchase Contracts*, INVESTOPEDIA (Mar. 3, 2017) https://www.investopedia.com/articles/personal-finance/102913/contingency-clauses-home-purchase-contracts.asp.

[99] *See* Linda Aparo, *5 Common Reasons a Real Estate Closing is Delayed*, [R]EQUIRE (Feb. 1, 2016), http://www.gorequire.com/blog/5-common-reasons-a-real-estate-closing-is-delayed.

The real estate industry is on the edge of deploying smart contracts.[100] An "International Blockchain Real Estate Association" focused on implementing blockchain in real estate formed in 2013,[101] and real-estate blockchain startups are exploring: (a) buying and selling leases; (b) funding real-estate development; and (c) timestamping and verifying legal agreements connected to leasing or purchasing apartments.[102] The National Association of Realtors ("NAR") invested in organizations considering smart contract implementations.[103] Additionally, in October 2017, the first property transaction using blockchain to facilitate payment and title transfer occurred.[104] However, wide-spread adoption will still likely depend on decisions from NAR and local agencies and multiple listing services, and their willingness to explore smart contract solutions.

IV. UNIVERSAL ADOPTION OF SMART CONTRACTS

The promise of smart contracts is clear, but the creation of ecosystems that support smart contracts is still in its early stages. Until parties are comfortable with absorbing the inherent risks of an automated contract, as discussed in Part II above, and until smart contract technology evolves to allow for more sophisticated implementations, smart contracts have some obvious limitations.

In order to realize the potential of smart contracts, and avoid the

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[100] *See* Stephen King, *How Blockchain Technology is Allowing for a Reinvention of the Real Estate Ecosystem*, FORBES (Mar. 13, 2018), https://www.forbes.com/sites/forbesrealestatecouncil/2018/03/13/how-blockchain-technology-is-allowing-for-a-reinvention-of-the-real-estate-ecosystem/#2449ca635a45.

[101] *Advancing Real Estate Into the 21st Century: International Blockchain Real Estate Association*, IBREA http://www.ibtcrea.org/ (last visited Apr. 15, 2018).

[102] *See* Brianne Rivlin, *Real Estate Meets Ethereum*, ETHNEWS (Oct. 19, 2016), https://www.ethnews.com/real-estate-meets-ethereum.

[103] *Id*.

[104] *See* Anthony Cuthbertson, *Blockchain Used to Sell Real Estate For the First Time*, NEWSWEEK (Oct. 12, 2017), http://www.newsweek.com/blockchain-sell-real-estate-first-time-ethereum-682982.

legal risks it is important to establish universal smart contracts standards and best practices. As a starting point, we think all users of smart contracts should agree on and adopt the following:

- **Jurisdiction and dispute resolution**—Current court systems and lawyers are not sophisticated enough, speedy enough, or otherwise equipped to adequately enforce smart contract disputes. A special smart contracts dispute resolution body (similar to the American Arbitration Association[105] or JAMS[106]) that can be referenced and embedded into a smart contract should be formed. Parties should agree via smart contract code that this independent body, not governmental courts, has jurisdiction. Dispute resolution of smart contracts could take place digitally online, so that parties in different countries could resolve disputes quickly and efficiently, without having to travel or incur other related expenses.

- **Universal Coding Standards**—A universal smart contracts language and coding standards should be developed and adopted, to prevent coding errors and deceit, and ensure a meeting of the minds. Drafting and coding standards should be adopted with the lay-person in mind. Universal smart contracts code should be open-sourced, so that everyone has equal access, and the equal ability to use standardized, security-audited, community-verified code.

- **A "Legal API" for Smart Contracts**—A universal "API" or set of contractual terms and contract triggers should be developed, using plain language together with the universal coding standards proposed above. A concrete set of rules for various common contractual terms and scenarios (e.g., payment terms, reps and warranties, indemnities, etc.) would go a long way to preventing misunderstandings in smart contract transactions, and, more importantly, would lead to

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[105] *American Arbitration Association*, AMERICAN ARBITRATION ASSOCIATION, https://www.adr.org/ (last visited Apr. 15, 2018).

[106] *JAMS Mediation, Arbitration, and ADR Services*, JAMS https://www.jamsadr.com/about-jams/ (last visited Apr. 15, 2018).

a greatly increased scope of transactions that can be carried out autonomously.

The above recommendations would help create a common framework that users, legal and non-legal, could build on to create norms for this new contractual medium.[107]

CONCLUSION

Smart contracts have the potential to disrupt the entire commercial and legal transactional landscape. However, entrenched impediments such as transaction-facilitating intermediaries like lawyers, banks, payment processors, commercial courts, and governments are sure to resist the self-executing contract revolution every step of the way. It is up to the legal and technical innovators on the front lines of the intersection of contracts and technology to ensure that a useable, fair, and universally adopted smart contracts standard are implemented, understood and accepted around the world.

[107] During the finalization of this paper for publication, the IEEE announced its intent to develop "techno-legal" standards for smart contracts, similar to our proposal in this section. *See IEEE and The Accord Project Partner to Develop Techno-Legal Standards for Smart Contract Applications*, BUSINESS WIRE (Feb. 20, 2018), https://www.businesswire.com/news/home /20180220005076/en/IEEE-Accord-Project-Partner-Develop-Techno-Legal-Standards). We look forward to seeing the evolution and eventual adoption of universal standards for smart contracts, whether via the IEEE and the Accord Project or another standard setting body.