

The Blockchain

Industry Applications and Legal Perspectives

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1. Introduction

Most people have heard of Bitcoin, the revolutionary decentralized, trustless payment system. But Bitcoin is just one application of a broader concept known as blockchain technology, or simply, 'the blockchain.' Blockchain technology made Bitcoin achieve a goal that many virtual currencies before it could not. In traditional payment systems, centralization is necessary to keep track of spending, and prevent 'double spending' of the same units. Users of the payment system must hence entirely trust these central authorities – usually, governments and banks. While there were virtual currencies before Bitcoin, including cryptocurrencies (i.e., currencies whose transactions are secured by cryptography), they remained centralized. The genius of Bitcoin was to distribute the ledger containing all Bitcoin transactions among each user (or 'node') in the network. Hence, every single transaction is authenticated by every single user (this is called 'proof of work'), and there is no centralized authority required for this. This is why blockchain technology is often referred to as 'distributed ledger' technology, and the blockchain is called a 'distributed ledger.'

We have separately published a research paper on the legal and tax consequences surrounding Bitcoin.¹ This research paper focuses on the broader concept of the blockchain itself.

Blockchain technology has attracted a lot of industry attention over the past two years. It has been proposed as a solution in areas ranging from finance to real estate to energy. Finance has probably been the sector which has given it the most attention. Nearly all the world's major financial institutions including Barclays, BNP Paribas, Goldman Sachs, J.P. Morgan, Morgan Stanley, NASDAQ, and Wells Fargo are exploring the application of the blockchain to their businesses, independently and through consortiums.² Big name technology

and consulting firms heavily involved in blockchain projects include Deloitte, Google (DeepMind), IBM, KPMG, and Microsoft.³ In India, blockchain technology has been called "the coolest thing in Indian finance".⁴ Banks that have run blockchain pilot runs include ICICI Bank, Yes Bank, Kotak Mahindra Bank, and Axis Bank. In addition⁵, Infosys, TCS, Wipro, and Cognizant have made significant investments in expanding their capabilities in the technology.⁶ Infosys and TCS were in fact the first two large companies globally to have rolled out the use of blockchain in core banking platforms.⁷ The use of blockchain in a variety of other sectors is being explored and is widely predicted.⁸ Governments too have shown interest in the technology, with the U.K. government in particular being a big backer.⁹

Significantly, the Reserve Bank of India's (RBI) research arm, the Institute for Development and Research in Banking Technology (IDRBT) released

1. Latest draft available at <http://www.nishithdesai.com/information/research-and-articles/research-papers.html> (last visited April 25, 2017)

2. E.g., <http://www.r3cev.com/about/> (last visited April 25, 2017); <http://entthalliance.org/> (last visited April 25, 2017)

3. E.g., <https://home.kpmg.com/sg/en/home/media/press-releases/2017/02/kpmgand-microsoft-announce-new-blockchain-nodes.html> (last visited April 25, 2017)

4. <https://qz.com/966629/blockchain-technology-is-the-coolest-thing-in-indian-finance-right-now-but-nobody-really-gets-it/> (last visited April 25, 2016)

5. *Id.*

6. <http://www.livemint.com/Companies/bXjPtHZRK-46FQVb2hxhyN/TCS-throws-weight-behind-blockchain.html>, <http://www.livemint.com/Companies/9bFMN9eyvtIDSS-JZa416w8M/Indian-IT-firms-eye-technology-behind-Bitcoin-for-disruptive.html>, <http://www.livemint.com/Companies/05UoISz199taRIdc5tDi5M/Wipro-steps-up-blockchain-focus.html> (last visited April 25, 2017)

7. <http://www.livemint.com/Companies/bXjPtHZRK-46FQVb2hxhyN/TCS-throws-weight-behind-blockchain.html> (last visited April 25, 2017)

8. E.g., <http://www.businessinsider.com/goldman-blockchain-beyond-the-hype-practical-uses-2016-5?r=UK&IR=T>; <http://www.bloomberg.com/news/articles/2016-05-19/built-for-bitcoin-blockchain-goes-beyond-crypto-currency>; <http://www.cio.com/article/3115776/internet/how-blockchain-will-disrupt-your-business.html>; <http://www.healthcareitnews.com/news/onc-unveils-winners-blockchain-health-it-challenge> (last visited April 25, 2017)

9. <http://www.zdnet.com/article/blockchain-as-a-service-approved-for-use-across-uk-government/>; see also <http://www.forbes.com/sites/laurashin/2016/04/21/republic-of-georgia-to-pilot-land-titling-on-blockchain-with-economist-hermano-de-soto-bitfury/#3016dcbd6550>, <http://www.coindesk.com/bitfury-working-with-georgian-government-on-blockchain-land-registry/> (last visited April 25, 2017)

a report in January 2017 confirming the cost-savings, transparency, and efficiency advantages of the technology and recommending that the time is ripe for its adoption in India.

Businesses across verticals should therefore be actively assessing how the blockchain can help streamline tasks for them. We hope this paper goes some way towards this.

The paper briefly describes the working of blockchain technology, discusses the current state of the art in industry, provides a legal and regulatory perspective, and concludes with a list of challenges and the way forward.

2. How Blockchain Technology Works

To understand its industry applications and legal ramifications, it is important to grasp how blockchain technology works.

One can think about the blockchain as a ledger of transactions. A physical ledger is typically maintained by a centralized authority, not by market participants. The blockchain, however, is a distributed ledger which resides on each participant's device. Each individual copy is updated in real time¹⁰ whenever a transaction is completed. The device of each participant or user is usually referred to as a 'node,' which forms part of a network of nodes.

the ledger as and when new transactions are authenticated. The process of authentication is based on advanced cryptography, and is widely considered to be secure in and of itself.¹² Hence, participants do not need to rely on a third party for transparency and authenticity. The blockchain ensures the transparency and integrity of transactions purely through mathematics, and not trust.

The type of transaction varies depending on the application of blockchain technology. In Bitcoin, for instance, each transaction is a transfer of a certain value of Bitcoin between participants,



Source: <http://www.imponderablethings.com/2013/07/how-bitcoin-works-under-hood.html>

The blockchain is unique because every node must authenticate every transaction in the network. This is why when a new node joins the network, the entire record of transactions is downloaded onto its system (for Bitcoin, this process now takes over 24 hours).¹¹ From then on, it will join the other nodes in updating

and every transaction is recorded on the Bitcoin blockchain. However, the transactions could also be for other uses, like fiat money transactions or real estate title transfers, as discussed later in this paper.

10. As a practical matter, transactions are usually processed in batches, or 'blocks', at intervals of, in most cases, a few minutes.

11. <http://www.imponderablethings.com/2013/07/how-bitcoin-works-under-hood.html> (last visited April 25, 2017)

12. *E.g.*, http://www.enigma.co/enigma_full.pdf (last visited April 25, 2017). However, aspects of the implementation of blockchain technology have been found vulnerable on many occasions (e.g., <http://www.businessinsider.com/dao-hacked-ethereum-crashing-in-value-tens-of-millions-allegedly-stolen-2016-6>) (last visited April 25, 2017), and this will be discussed in more detail subsequently in this paper.

Technical Perspective ¹³

To delve into some technical detail, when a node 'X' seeks to carry out a transaction (e.g., send 5 units from X to Y), it sends a transaction message, represented in computer code, to the network. To become an accepted transaction recorded on the blockchain (in this case, for 5 units to be considered transferred), this transaction message must be authenticated by every node in the network.

The authentication is done on the basis of the digital signature accompanying the message. Every node possesses a public and private cryptographic key. The public key is akin to a mailing address, to enable other nodes to communicate with it (send money, sign contracts etc.). The private key is akin to a secure password that only its holder knows. Whenever a node sends out a transaction message, a digital signature is generated using its private key and the message. The digital signature enables other nodes in the network to verify that the sender is really the holder of a given private key. Digital signatures hence enable the network to verify the authenticity of messages, preventing fraud by impersonation.

Once the digital signature of a transaction is authenticated, it gets pooled with other authenticated transactions into a 'block.' After the first block, a series or 'chain' of blocks gets formed, hence leading to the term 'blockchain.' This is where a second level of cryptography comes in.

To prevent fraud and double spending, it is important that the order of transactions is authentic. This is because a transaction message reaches different nodes at different points in time (owing to varying network speeds). So, without a secure mechanism to order transactions, a buyer could send a payment, and ¹³ before that message reaches the seller, the

buyer could send the amount back to itself.¹⁴ Some nodes in the network may receive the second message before the first. The seller may have relied on the original payment message and shipped the goods, only to be left then without payment! This is because the buyer was able to capitalize on the varying times at which each node received the transaction messages, hence effectively manipulating the order of transactions.

Several cryptocurrencies prior to bitcoin suffered from this problem. It was hence necessary for there to be a secure way of determining an order of transactions which could be accepted by all nodes as true. Blockchain technology achieves this. It establishes a system through which the order cannot be manipulated unless the majority of the computing power in the network colludes to make it so (even then, manipulation is not guaranteed).

How? Every block is encrypted using a cryptographic hash function. Transactions in the block can only be read and made sense of after the block is decrypted. But the text of each block relies on the previous block, so to decrypt a given block, the previous block must be known. This prevents the chain splitting into numerous parts,¹⁵ and results in a mechanism to achieve consensus on the ordering of transactions.

Because of the strength of the cryptographic hash function involved, a great deal of computing power is required for decryption. Every node in the network participates to work towards decrypting each block. This process is known as 'mining' and nodes doing this are called 'miners'. Incidentally, miners in the Bitcoin blockchain are rewarded for their work with Bitcoin value.

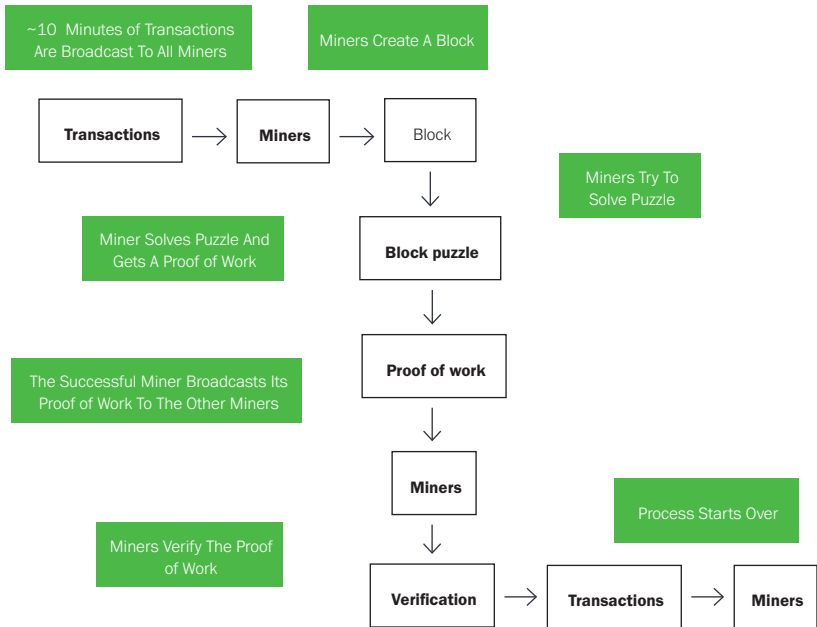
13. The technical explanation here is on the basis of the blog and video, "How Bitcoin Works Under the Hood" by Scott Driscoll, available at <http://www.imponderablethings.com/2013/07/how-bitcoin-works-under-hood.html> (last visited April 25, 2017)

14. <http://www.imponderablethings.com/2013/07/how-bitcoin-works-under-hood.html> (last visited April 25, 2017)

15. In rare cases, there may be parallel chains for a short length of time, but since nodes follow the longest chain, this matter is resolved quickly.

This is what incentivizes them to keep authenticating transactions. When there are no more or too few Bitcoins to mine (the system is designed such that will be no more 'new' Bitcoins in 2140), nodes may be paid transaction fees.

This discussion helps in revealing some features of the blockchain that are relevant to its industry applications and legal implications.



BI Intelligence

Source: Business Insider,¹⁶ bullfax.com¹⁷

The “work” involved in mining is not manual human work, and is performed by each node’s device without human intervention. In simple terms, it is large-scale trial-and-error guesswork until the correct mathematical answer is reached. Therefore, like with digital signatures, the order of transactions is decided by mathematics and not trust or third party discretion.

Once a block is authenticated, the ledger in all nodes is updated with the new transactions in that block, and so forth.

The blockchain is likely best used when:

1. There are a series of transactions / events.
2. They need to be recorded.
3. They need to be verified.

Verification occurs with respect to:

- a. The integrity of the information, and
- b. The integrity of the order of events.

16. <https://intelligence.businessinsider.com/how-bitcoin-works-and-could-change-payments-2014-1> (last visited April 25, 2017)

17. <http://www.bullfax.com/?q=node-bitcoin-how-it-works-and-why-it-could-fundamentally-cha> (last visited April 25, 2017)

4. There are several participants in the system.
5. Transparency is important.
6. Decentralization is important.
7. Permanence is important.

Based on these features, it is easy to see why some of the leading use cases being proposed for the blockchain are financial clearing and settlement and many record-keeping functions, like the maintenance of real estate records.

3. State of the Art in Industry

The discussion on the current industry state of the art is best divided by speaking of:

1. Platforms – These are targeted at developers who can use the platform to build blockchain-based applications that can then be used by end-users (enterprises or consumers). A well-known example is the ‘Ethereum’ platform.
2. Blockchain Solutions – These are targeted at organizations who wish to deploy blockchain technology for custom use in their organization, but need professional assistance to do so. This assistance may be through product or service offerings. Microsoft’s ‘Azure Blockchain as a Service’ is a significant example.
3. Applications – These are the fruits of the underlying technology, and are designed to accomplish specific tasks for end-users that lead to tangible results (e.g., payment and settlement, record-keeping, and voting).

I. Platforms

A. Ethereum

After Bitcoin, Ethereum is probably the most well-known deployment of blockchain technology, and is in fact the second largest cryptocurrency in the world after Bitcoin.¹⁸ It was conceived in 2013 by Vitalik Buterin, a young programmer (just 19 years old at the time) who was heavily involved in research and writing on Bitcoin, cryptocurrencies, and their underlying technology i.e., the blockchain. He released a white paper, “*A Next-Generation Smart Contract and Decentralized Application Platform*”¹⁹ which proposed a system through which blockchain technology could be

used in applications beyond Bitcoin and cryptocurrencies.

This is because Ethereum is written in a scripting language that is fully-functional, or ‘Turing-complete,’ as opposed to Bitcoin which was designed only to facilitate exchanges of Bitcoin value.²⁰ Ethereum is based on ‘smart contracts,’ which are computer protocols that allow transactions between users to be programmed and then executed automatically (as opposed to then existing blockchain technology which only kept a *record* of transactions).²¹ For example, a smart contract can allow a buyer to make payment (automatically) only after goods or services are actually delivered. If the parties have agreed what the delivery event is, this can be programmed into the smart contract, which will automatically debit the buyer’s account once delivery has occurred. It is easy to see how this system can support complex commercial transactions, eliminating manual labour and human error.

Buterin envisaged three types of applications for Ethereum:²²

- i. Financial: These refer to purely financial uses and include financial derivatives, hedging contracts, savings wallets, and wills.
- ii. Semi-financial: These refer to uses where there is both a monetary and a non-monetary side to the transaction. Buterin’s example is of self-executing rewards to programmers for solutions to computational problems.

18. <https://www.investing.com/analysis/daily-market-updates-200179281> (last visited April 25, 2017)

19. <https://github.com/ethereum/wiki/wiki/White-Paper> (last visited April 25, 2017)

20. <https://techcrunch.com/2015/08/01/vapor-no-more-ethereum-has-launched/> (last visited April 25, 2017)

21. “*They are pieces of software, not contracts in the legal sense, that extend blockchains’ utility from simply keeping a record of financial transaction entries to automatically implementing terms of multi-party agreements.*” <https://www2.deloitte.com/us/en/pages/finance/articles/cfo-insights-getting-smart-contracts.html> (last visited April 25, 2017); <http://www.ethnews.com/smart-contracts> (last visited April 25, 2017)

22. <https://github.com/ethereum/wiki/wiki/White-Paper> (last visited April 25, 2017)

- iii. Non-financial: These refer to applications such as online voting.

Ethereum's initial release was in July 2015, and it quickly became a buzzword in technology circles. Numerous startups began and continue to construct applications based on its platform. Microsoft's offering of Ethereum as part of its cloud platform 'Azure,'²³ is likely to lead mainstream use of the Ethereum platform. In fact, thirty large banks, technology companies, and other organizations, including Banco Santander, J.P. Morgan Chase, Microsoft, and Intel, in February 2017 formed the 'Enterprise Ethereum Alliance.'²⁴

Ethereum has also been the subject of controversy. Recently, a massive user of Ethereum, 'The DAO,' a decentralized autonomous organization which pooled money from investors (as a kind of decentralized investment fund), was involved in a cybersecurity breach. Its underlying code was exploited, enabling unidentified hackers to siphon off cryptocurrency (Ethereum units called 'ether') worth tens of millions of U.S. dollars (some estimates say USD 60 million).²⁵ After much debate, the Ethereum community reached a technical solution (a 'hard fork') that enabled much, but not all, of the stolen cryptocurrency to be rolled back.²⁶ Though blockchain technology as such is widely acknowledged to be secure, the breach shows that its implementation, especially in high-value contexts, can be risk-ridden unless done with extreme care. The breach has led to some skepticism as to the extent to which blockchain technology can replace laws and financial institutions as securers of commercial transactions.²⁷

23. Details follow in the next section.

24. <http://fortune.com/2017/02/28/ethereum-jpmorgan-micro-soft-alliance/> (last visited April 25, 2017)

25. <http://fortune.com/2016/06/18/blockchain-vc-fund-hacked/http://www.coindesk.com/author-daos-original-code-minimize-regulatory-backlash/> (last visited April 25, 2017)

26. <http://fortune.com/2016/09/04/ethereum-fall-out/> (last visited April 25, 2017)

27. *Id.*

B. Bitcoin and Colored Coins

Though a discussion of Bitcoin as such is outside the scope of this paper, the Bitcoin blockchain can be used for applications other than the exchange of Bitcoin value. 'Colored Coins' is an open source protocol that allows developers to use the Bitcoin blockchain for applications beyond currency, for nearly any exchange of value that can occur online.²⁸ Also, Blockstack Inc. has developed 'Blockstack,'²⁹ which uses the Bitcoin blockchain and supports applications for uses such as payment and settlement, recording and transfer of digital assets, and smart contracts.³⁰

C. Chain Protocol

Chain is a leading blockchain-focused organization which is partnering with several well-known financial organizations to "build, deploy, and operate blockchain networks that enable breakthrough financial products and services."³¹ The impressive list of its partners includes Capital One, Citigroup, Fiserv, Nasdaq, Orange, State Street, and Visa, among others.³² It has authored 'Chain Protocol', an open source blockchain protocol that "defines how assets are issued, transferred, and controlled on a blockchain network."³³ The protocol was designed with financial services in mind and is claimed to ensure transaction finality as well as protect privacy.³⁴ According to its whitepaper, Chain Protocol is claimed to allow the implementation of "a wide range of financial instruments (such as options, bonds, and swaps), security schemes (for storing assets), and applications such as offers, escrows, and auctions."³⁵ Chain also provides

28. <http://coloredcoins.org/> (last visited April 25, 2017)

29. <https://blockstack.com/>, <https://blockstack.org/> (last visited April 25, 2017)

30. <http://coloredcoins.org/>; <https://www.dxmarkets.com/>; <https://mycelium.com/> (last visited April 25, 2017)

31. <https://chain.com/faq/> (last visited April 25, 2017)

32. *Id.*

33. <https://chain.com/technology/> (last visited April 25, 2017)

34. *Id.*

35. <https://chain.com/docs/1.1/protocol/papers/whitepaper#4-programs> (last visited April 25, 2017)

blockchain solutions to enterprises, and this is discussed in the next section.

II. Blockchain Solutions

A. Azure Blockchain as a Service

Microsoft Azure, which is a leading cloud service provider (in the same space as Amazon Web Services), now offers Blockchain as a Service (BaaS) as part of its cloud offering. Microsoft describes the service, 'Azure Blockchain as a Service,' as a "single click cloud based blockchain developer environment."³⁶ It is meant to allow enterprises, business networks, and developers to experiment and collaborate on blockchain deployment.³⁷ It was first announced in 2015, and integrates various existing distributed ledger technologies including the Ethereum blockchain and Eris (discussed below).

B. Chain

Chain, mentioned earlier, is building blockchain networks targeted at the financial industry.³⁸ It offers 'Chain Core,' enterprise software that enables organizations to carry out financial transactions on permissioned blockchain networks.³⁹ Organizations can use this to launch and operate a blockchain network, or join other blockchain networks related to financial transactions.⁴⁰

C. Monax

Monax is an enterprise platform for "building, testing, maintaining, and operating ecosystem applications with a blockchain backend."⁴¹ It uses aspects of Ethereum, with changes, to customize

blockchain technology for industry adoption, and is part of the Enterprise Ethereum Alliance mentioned previously.⁴² It is primarily targeted at developers in enterprises, and according to Microsoft, "[t]he [Monax] platform greatly reduces the complexity of creating blockchain-based applications. ... [Monax] also makes it simple and easy for your organization to get started using permissionable [i.e., access-controlled], smart-contract capable blockchains."⁴³ Monax was one of the strategic partners appointed by PricewaterhouseCoopers (PwC) for its blockchain solutions portfolio.⁴⁴

III. Applications

This section discusses some notable existing and proposed industry applications of the blockchain.

A. Financial Services / Fintech

i. Banking

In a recent report, Deloitte identified 'trade clearing and settlement' as one among two use-cases of smart contracts that were most immediate to market.⁴⁵ This makes the banking industry a huge potential market for the blockchain. As mentioned in the Introduction, Infosys and TCS are the first large companies to roll out the use of blockchain technology in core banking platforms.⁴⁶

42. <https://monax.io/tags/ethereum/>

43. <https://azure.microsoft.com/en-in/blog/azure-blockchain-as-a-service-update-4/> (last visited April 25, 2017)

44. <https://bitcoinformagazine.com/articles/pwc-partners-with-blockstream-and-eris-industries-to-create-blockchain-solution-portfolio-1454359482> (last visited April 25, 2017)

45. <https://www2.deloitte.com/us/en/pages/finance/articles/cfo-insights-getting-smart-contracts.html> (last visited April 25, 2017). The other use case is supply chain and trade finance documentation, mentioned under the 'Legal Services' section subsequently.

46. "A core banking system is the back-end data processing application for processing all transactions that have occurred during the day and posting updated data on account balances to the mainframe. Core systems typically include deposit account and CD account processing, loan and credit processing, interfaces to the general ledger and reporting tools." <http://www.gartner.com/it-glossary/core-banking-systems/> (last visited April 25, 2017)

36. <https://azure.microsoft.com/en-us/blog/ethereum-blockchain-as-a-service-now-on-azure/> (last visited April 25, 2017)

37. <https://azure.microsoft.com/en-us/solutions/blockchain/> (last visited April 25, 2017)

38. <https://chain.com/> (last visited April 25, 2017)

39. <https://chain.com/faq/> (last visited April 25, 2017)

40. <https://chain.com/technology/> (last visited April 25, 2017)

41. <https://monax.io/platform/> (last visited April 25, 2017)

A recent report by the innovation fund of Santander Bank predicts cost-savings of USD 15 to 20 billion by 2022, as a result of blockchain technology reducing financial infrastructure costs.⁴⁷ Smart contracts add to the ledger functionality of blockchain technology, allowing many kinds of self-executing instructions to be programmed into the blockchain. With the blockchain as the single source of truth, requiring no manual verification, smart contracts can automate approval workflows and clearing calculations.⁴⁸ These processes are cost- and labor-intensive, and are subject to delay and human error.⁴⁹ This is exacerbated by each bank / financial institution having to independently process transactions.⁵⁰

Several financial institutions, investment funds, and financial infrastructure bodies have taken notice of the potential impact of blockchain technology on clearing and settlement. The two consortiums R3 and Enterprise Ethereum Alliance together boast nearly 100 leading financial institutions.⁵¹ Investors in blockchain startups in the clearing and settlement space include Khosla Ventures, SV Angel, Citigroup, JP Morgan, and Santander.⁵² Recently, the Depository Trust & Clearing Corporation (DTCC), the premier post-trade market infrastructure organization in global finance, announced a project to deploy blockchain technology for the clearing and settlement of a huge swathe of repurchase agreement (repo) transactions.⁵³ Also recently, seven major European financial institutions, including BNP

Paribas Securities, announced a Memorandum of Understanding to explore the development of a post-trade blockchain-based infrastructure for small and medium enterprises in Europe.⁵⁴ Closer home, in February 2017, India's largest bank, State Bank of India, announced a consortium "Bankchain" including 10 commercial banks, IBM, Microsoft, and KPMG, proposing to move trade finance and loan documentation to the blockchain.⁵⁵ As mentioned above, Axis Bank, ICICI Bank, IDFC Bank, Kotak Mahindra Bank, and Yes Bank have carried out blockchain pilot runs for vendor financing and international trade finance.⁵⁶ For example, Yes Bank and IDFC Bank partnered with a blockchain-driven fintech startup, 'Uphold,' to enable cross-border payments into India.⁵⁷ The National Payments Corporation of India (NPCI) recently held an "ideathon," and has set up a working group, to help it understand the implications of blockchain technology.⁵⁸

Interest has extended to the public sector too. In June 2016, Central bank officials from over 90 countries, including the Chair of the U.S. Federal Reserve, and officials from the International Monetary Fund, World Bank and the Bank for International Settlements attended a keynote talk on the blockchain by the CEO of Chain.⁵⁹ He explained how blockchain technology can help them *"operate the digital networks themselves, issue digital assets, hold those assets, create products and services to run on those networks or just observe*

47. <http://deloitte.wsj.com/cfo/2016/06/23/getting-smart-about-smart-contracts/>; <http://santanderinnovations.com/wp-content/uploads/2015/06/The-Fintech-2-0-Paper.pdf> (last visited April 25, 2017)

48. <http://deloitte.wsj.com/cfo/2016/06/23/getting-smart-about-smart-contracts/> (last visited April 25, 2017)

49. *Id.*

50. *Id.*

51. <http://www.r3cev.com/about/https://r3cev.com/press/2016/8/31/press-release-metlife-joins-r3-distributed-ledger-consortium> (last visited April 25, 2017); <http://entethalliance.org/> (last visited April 25, 2017)

52. *Id.*

53. <http://deloitte.wsj.com/cfo/2016/06/23/getting-smart-about-smartcontracts/>; <http://www.dtcc.com/news/2016/march/29/dtcc-and-digital-asset-to-develop-distributed-ledger-solution> (last visited April 25, 2017)

54. <http://www.businesswire.com/news/home/20160621006306/en/Euronext%20Major-Financial-Institutions-Join-Forces-Develop> (last visited April 25, 2017)

55. <http://economictimes.indiatimes.com/markets/stocks/news/sbi-takes-lead-in-blockchain-to-use-it-to-prevent-fraud/article-show/57178212.cms?from=mdr> (last visited April 25, 2017)

56. <https://qz.com/966629/blockchain-technology-is-the-coolest-thing-in-indian-finance-right-now-but-nobody-really-gets-it/> (last visited April 25, 2017)

57. *Id.*

<https://uphold.com/en/blog/posts/uphold/uphold-opens-cross-border-payments-to-india> (last visited April 25, 2017)

58. <http://timesofindia.indiatimes.com/business/india-business/Next-Banking-Disruption-Lies-In-One-Open-Online-Ledger/articleshow/54318646.cms> (last visited April 25, 2017)

59. <http://www.bloomberg.com/news/articles/2016-06-06/central-bankers-told-they-should-be-sprinting-toward-block-chain> (last visited April 25, 2017)

them.⁶⁰ In fact, the governments of Canada, China, Japan, Netherlands, the U.K., and Sweden have all been reported to be exploring the issuance of digital versions of fiat currency on the blockchain.⁶¹

In India, as mentioned previously, the IDRBT released a report in January 2017 confirming the cost-savings, transparency, and efficiency advantages of blockchain technology. Significantly, it observed, “*having had a good understanding of the various aspects around the blockchain technology ... we recommend that the time is ripe for its adoption in India.*”⁶² In addition, RBI Deputy Governor R.S. Gandhi in March 2017 mentioned that digitally issued fiat currency on the blockchain is a possibility, albeit one that will require extensive research.⁶³ More detail on the RBI’s perspective is covered under Section 4 (“**Regulatory Reaction**”) below.

ii. Securities

In 2015, Nasdaq announced an enterprise-wide initiative to leverage blockchain technology.⁶⁴ Its first use was to “*offer efficient, fully-electronic services that facilitate the issuance, transfer, and management of private company securities.*”⁶⁵ It is also using the technology to enable some public companies’ shareholders exercise their corporate voting rights.⁶⁶

Significantly, in May 2016, it announced the ‘Nasdaq Financial Framework,’ which is an end-to-end solution for its financial infrastructure clients around the world, including traditional

exchanges.⁶⁷ The Framework allows clients to leverage blockchain technology, as one of many other capabilities, including machine learning, for their individual needs.⁶⁸

Nasdaq was one of the first multinational financial services companies to begin using the blockchain in a non-currency manner.⁶⁹ It sees the blockchain as providing “*extensive integrity, audit ability, governance and transfer of ownership capabilities.*”⁷⁰

Following in its lead, several other stock and commodity exchanges, including India’s National Stock Exchange (NSE) and Bombay Stock Exchange (BSE), the New York Stock Exchange, the London Stock Exchange, the Japan Exchange Group, the Deutsche Börse, the Dubai Multi Commodities Centre, the Australian Securities Exchange, and the Sydney Stock Exchange have been investigating the potential of blockchain technology to varying extents.⁷¹ In February 2017, the NSE, along with ICICI Bank, IDFC Bank, Kotak Mahindra Bank, IndusInd Bank, RBL Bank, HDFC Securities, and Blockchain startup Elemental, recently jointly conducted a Know Your Customer (KYC) data trial using the blockchain.⁷² The NSE was also reported to be experimenting with the use of blockchain technology to ensure settlement guarantees.⁷³ Additionally, an Indian startup, uTrade aims to use blockchain technology for instant stock trade settlements.⁷⁴ The NSE recently held a widely-attended conference on

60. *Id.*

61. https://www.bbvaesearch.com/wp-content/uploads/2016/12/WP_16-20.pdf (last visited April 26, 2017)

62. <http://www.idrft.ac.in/assets/publications/Best%20Practices/BCT.pdf> (last visited April 25, 2017)

63. <http://www.coindesk.com/indian-central-banker-potential-blockchain-currencies-overstated/> (last visited April 25, 2017)

64. <http://ir.nasdaq.com/releasedetail.cfm?releaseid=912196> (last visited April 25, 2017)

65. *Id.*

66. <https://www.bloomberg.com/news/articles/2016-08-25/this-is-your-company-on-blockchain>; <http://www.coindesk.com/nasdaq-shareholder-voting-estonia-blockchain/> (last visited April 25, 2017)

67. <http://www.coindesk.com/nasdaqs-blockchain-services-global-exchange/> (last visited April 25, 2017)

68. <http://business.nasdaq.com/market-tech/nasdaq-financial-framework> (last visited April 25, 2017)

69. <http://ir.nasdaq.com/releasedetail.cfm?releaseid=912196> (last visited April 25, 2017)

70. *Id.*

71. <http://www.coindesk.com/10-stock-exchanges-blockchain/>; <http://www.zdnet.com/article/sydney-stock-exchange-to-implement-instant-blockchain-based-settlements/> (last visited April 25, 2017)

72. <http://www.coindesk.com/india-stock-exchange-blockchain-kyc/> (last visited April 25, 2017)

73. <http://computer.financialexpress.com/news/nse-looking-at-blockchain-for-ensuring-settlement-guarantees/18956/> (last visited April 25, 2017)

74. <http://www.newsbtc.com/2016/06/16/indian-startup-adopts-blockchain-stock-trade-settlements/> (last visited April 25, 2017)

blockchain technology, comprising speakers from R3, Nasdaq, JP Morgan Chase, IBM, TCS, and the NSE itself, among others.⁷⁵ The BSE has also hosted a blockchain-focused hackathon.⁷⁶

iii. Derivatives

Derivatives are financial instruments that derive value from underlying assets, which could include stocks, bonds, commodities or even interest rates.⁷⁷ The White Paper which conceptualized Ethereum called financial derivatives “*the most common application of a ‘smart contract’*”.⁷⁸ Various industry experts have predicted that blockchain technology can lead to more customized financial engineering, “*enabling financiers to customize derivatives consisting of individual cash flows to meet precise needs in terms of timing and credit risk.*”⁷⁹ This engineering can be done using the various platforms, solutions, and frameworks discussed above, or through specialized blockchain derivatives players like HitFin.⁸⁰

B. Legal Services

While ‘smart contracts’ do not refer to contracts in the legal sense, legal contracts are an important application of them. As mentioned, contractual obligations like payment and delivery can be programmed to self-execute once given conditions are satisfied e.g., payment can be automatically made once a delivery event is proven (the delivery would also be automatically verified on the blockchain). This drastically reduces the resources that have to be spent on contract management i.e., ongoing monitoring and compliance with contractual obligations. Additionally, decentralization and math-based verification removes the need for trust-based execution of contractual obligations. A significant way this can be put to use is in supply chain and trade finance documentation, by automating processes “*previously spread across multiple parties and databases.*”⁸¹

Barclays has taken the lead in adopting ‘Smart Contract Templates,’ supported by R3. This has the capacity of automating the extensive legal documentation process involved in many banking and finance transactions. The impressive demo can be viewed at <http://r3cev.com/projects/> (<https://perma.cc/SKM5-EWFQ>).

75. http://www.nishithdesai.com/fileadmin/user_upload/pdfs/Event/NSE_Future_Tech_2016.pdf (last visited April 25, 2017)

76. <http://www.coindesk.com/ibm-blockchain-hackathon-india/> (last visited April 25, 2017)

77. <https://bitcoinmagazine.com/articles/blockchain-technology-will-profoundly-change-the-derivatives-industry-1464368431> (last visited April 25, 2017)


78. <https://github.com/ethereum/wiki/wiki/White-Paper#applications> (last visited April 25, 2017)

79. <https://bitcoinmagazine.com/articles/blockchain-technology-will-profoundly-change-the-derivatives-industry-1464368431> (last visited April 25, 2017)


80. <http://www.fusionwire.net/featured/hitfins-blockchain-shines-a-light-into-derivatives-trading/> (last visited April 25, 2017)

81. <http://deloitte.wsj.com/cfo/2016/06/23/getting-smart-about-smart-contracts/> (last visited April 25, 2017)

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Credit Support Annex 1995 - England and Wales

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determined for each relevant currency and calculated for each day in that Interest Period on the principal amount of the portion of the Credit Support Balance comprised of cash in such currency, determined by the Valuation Agent for each such day as follows:

(x) the amount of cash in such currency on that day; multiplied by
 (y) the relevant Interest Rate in effect for that day; divided by
 (z) 360 (or, in the case of pounds sterling, 365)

```
{
  "id": "DailyInterestAmount",
  "type": "Expression",
  "value": "(CashAmount * InterestRate) / (If Currency == 'GBP' then 365 else 360)"
}
```

"Interest Period" means the period from (and including) the date on which the Local Business Day on which the current interest amount is transferred to (and including) the date on which the current interest amount is transferred to (but excluding) the Local Business Day on which the current interest amount is transferred.

"Interest Rate" means, with respect to an Eligible Currency, the rate specified in Paragraph 11(f)(i) for that currency.

A still from Barclays' demo of smart contract templates, where legal prose is shown converted to computer code.

Credit: Barclays, R3. Source: <https://vimeo.com/168844103>

Similarly, ChainThat, a startup, is offering a blockchain-based legal contract management system to enterprises.⁸² The solution uses the blockchain for the creation, negotiation, version control, and signing of contracts.⁸³

C. Real Estate and Government Services

Real estate transactions around the world are usually time-consuming and bureaucratic. Because it is a trustless, decentralized system, the blockchain can remove the need for middlemen, disrupt existing identity verification processes (through digital IDs), reduce the risk of fraud (by creating incorruptible, digital ownership certificates for each property), and track the regulatory compliance of the property.⁸⁴ Transactions once completed would be immutably recorded in a distributed ledger (just as, for instance, Bitcoin transactions are currently done), with very little scope for doubt or manipulation.

There is an International Blockchain Real Estate Association (IBREA) which notes that the "[b]lockchain offers an open source, universal protocol for property buying, conveyancing, recording, escrow, crowdfunding, and more. It can reduce costs, stamp out fraud, speed up transactions, increase financial privacy, internationalize markets, and make real estate a liquid asset."⁸⁵

It is not surprising, therefore, that some governments are implementing or actively exploring the use of blockchain technology for their real estate record systems, including Sweden, some U.S. jurisdictions, Brazil, Georgia, Ukraine, and Ghana.⁸⁶ 'Ubitquity' offers a real estate blockchain platform that has already begun to be used for real-world property transfers.⁸⁷

'REIDAO' offers a system for pooling and transacting in portions of real estate.⁸⁸ But real estate is not the only government service that holds potential for the blockchain. The

85. <http://www.ibtcrea.org/> (last visited April 25, 2017)

86. <https://www.weforum.org/agenda/2016/08/how-disruptive-technology-could-solve-real-estate-s-transparency-problem/>; <http://www.coindesk.com/blockchain-land-registration-solution-seeking-problem/> (last visited April 25, 2017)

87. <http://www.ibtimes.co.uk/blockchain-powered-real-estate-platform-ubitquity-does-first-property-ownership-transfer-bitcoin-1569980>; <https://www.ubitquity.io/> (last visited October 3, 2016) <https://cointelegraph.com/news/us-based-startup-ubitquity-brings-blockchain-to-brazils-real-estate> (last visited April 25, 2017)

88. <http://www.nasdaq.com/article/democratizing-real-estate-investing-with-blockchain-technology-cm768475> (last visited April 25, 2017)

82. <http://www.chainthat.com/solutions/> (last visited April 25, 2017)

83. *Id.*

84. <https://techcrunch.com/2016/02/06/3-ways-that-blockchain-will-change-the-real-estate-market/>; <https://www.weforum.org/agenda/2016/08/how-disruptive-technology-could-solve-real-estate-s-transparency-problem/> (last visited April 25, 2017)

blockchain's features of decentralization and immutability have seen it garner interest by governments around the world for a range of services.⁸⁹ Besides the real estate initiatives already mentioned, the governments of Delaware, U.S.; Estonia; Malta; Russia; Singapore; South Korea; the U.K.; and Vermont, U.S., are exploring the use of the blockchain for a variety of services ranging from banking and finance to healthcare.⁹⁰ Delaware in 2016 started the Delaware Blockchain Initiative, which aims to use blockchain technology in three ways: (i) At the Delaware Public Archives to automate compliance with laws pertaining to retention and destruction of archival documents (this has already been accomplished); (ii) To enable 'smart' Uniform Commercial Code (UCC) filings, traditionally "*paper-based, slow and error-prone*"; and (iii) To introduce distributed ledger shares (discussed in more detail in Section 4 ("**Regulatory Reaction**") below).⁹¹ Similarly, the U.K. is interested in the potential of the blockchain both for its own services and as a catalyst for technology innovation in industry.⁹² In April 2017, Malta expressed its ambition to become a leader in adopting bitcoin and blockchain technology, announcing a national strategy to promote these technologies and use them for purposes like land and healthcare registries.⁹³

D. Intellectual Property (IP)

Like with real estate, the blockchain's properties make its application suitable to IP records and transactions. Works can be transferred and licensed with the accompanying terms, rights, and prices encoded on to them. Monegraph is an

89. <http://observer.com/2016/09/why-the-blockchain-is-perfect-for-government-services/> (last visited April 25, 2017)

90. *Id.*

91. <https://corpgov.law.harvard.edu/2017/03/16/delaware-blockchain-initiative-transforming-the-foundational-infrastructure-of-corporate-finance/> (last visited April 25, 2017)

92. <https://bitcoinmagazine.com/articles/u-k-government-awards-framework-agreement-to-blockchain-as-a-service-company-credits-1470687028>; www.coindesk.com/uk-blockchain-regulatory-approval (last visited April 25, 2017)

93. <https://cointelegraph.com/news/suddenly-europe-is-starting-to-become-bitcoin-haven> (last visited April 26, 2017)

organization that facilitates this.⁹⁴ Its solutions help content owners and media businesses with rights management, revenue sharing, and distribution.⁹⁵ Ampliative Art is a non-profit organization that uses blockchain technology to help artists get rewarded for their work through donations and grants.⁹⁶

The blockchain is also being used by some startups to facilitate the development of video games,⁹⁷ and the trading of digital game content.⁹⁸

E. Insurance

The blockchain's applications to insurance involve the streamlining of documentation, Anti-Money-Laundering / Know Your Customer (AML/KYC) processing, and claim processing.⁹⁹ This would be especially useful for wholesale insurance providers.¹⁰⁰ According to Deloitte, smart contracts can help in insurance claim processing by automating error checking, routing and approval workflows, and calculating payout, based on the type of claim and the underlying policy.¹⁰¹ They can also facilitate micro-insurance, such as pay-as-you-go automotive insurance, by processing micropayments based on usage data generated by connected devices (including Internet of Things devices).¹⁰²

ChainThat, mentioned earlier, has adapted blockchain technology to develop a decentralized platform for the commercial,

94. <https://monegraph.com/> (last visited April 25, 2017)

95. <https://monegraph.com/everywhere> (last visited April 25, 2017)

96. <http://www.ampliativeart.org/en/faq/>; <http://www.ampliativeart.org/en/example/>; <http://www.ampliativeart.org/en/development/> (last visited April 25, 2017)

97. <http://www.trustlessprivacy.com/> (last visited April 25, 2017)

98. <http://ownage.io/> (last visited April 25, 2017)

99. <http://www.businessinsider.com/heres-how-blockchain-can-help-the-wholesale-insurance-industry-2016-8?r=UK&IR=T>; see also <https://proofofphysicaladdress.com/>. (last visited v)

100. <http://www.businessinsider.com/heres-how-blockchain-can-help-the-wholesale-insurance-industry-2016-8?r=UK&IR=T> (last visited April 25, 2017)

101. <http://dupress.deloitte.com/dup-us-en/focus/signals-for-strategists/using-blockchain-for-smart-contracts.html?top=4> (last visited April 25, 2017)

102. *Id.*

specialty (re)insurance insurance industry.¹⁰³ A startup called Dynamis is using smart contracts to build a *“peer to peer supplemental unemployment insurance protocol which uses policy holders’ social capital to replace underwriters.”*¹⁰⁴

F. Healthcare

The blockchain can be leveraged to streamline processes centered around healthcare data. It can store and control access to electronic medical records and health monitoring data generated by patients.¹⁰⁵ It can also link micropayments and rewards (set for patients under health plans) to this information, so that they are automatically disbursed when thresholds/milestones are met.¹⁰⁶

Gem Health is an enterprise solution offering blockchain infrastructure for wellness apps, electronic medical records, global patient ID software, medical inventory management, and rehabilitation incentive programs.¹⁰⁷ It recently announced a partnership with Philips.¹⁰⁸

G. Other Fields

The blockchain has been called “the big breakthrough,” the “Internet of Finance,” the “Internet of Trust,” and the “Internet of Value.”¹⁰⁹ It is a wide-ranging innovation, so there is no end to the types of applications that it is being

extrapolated to.¹¹⁰ To illustrate, below are some additional fields in which it is being explored:

- i. Accounting: The blockchain could save time and effort in accounting by obviating existing auditing processes.¹¹¹
- ii. Education and Employment: Some educational institutions have begun recording students’ academic credentials and achievements on the blockchain, so that prospective employers can be confident that the credentials they receive are authentic.¹¹²
- iii. Energy: There are ventures aiming at creating an energy data exchange platform,¹¹³ and a platform for distributed solar power.¹¹⁴
- iv. Extension to the Physical Realm: Slock. it is a startup that enables machines (e.g., Internet of Things devices) to operate autonomously.¹¹⁵ There are also proposals for decentralized ridesharing services,¹¹⁶ and a way to automatically prove one’s physical address.¹¹⁷

103. <http://www.chainthat.com/framework/> (last visited April 25, 2017)

104. <http://www.dynamisapp.com/vision.html> (last visited April 25, 2017)

105. <http://dupress.deloitte.com/dup-us-en/focus/signals-for-strategists/using-blockchain-for-smart-contracts.html?top=4> (last visited April 25, 2017)

106. *Id.*

107. <https://gem.co/health> (last visited April 25, 2017)

108. <https://bitcoinmagazine.com/articles/the-blockchain-for-healthcare-gem-launches-gem-health-network-with-philips-blockchain-lab-1461674938> (last visited April 25, 2017)

109. <http://fortune.com/2016/05/08/why-blockchains-will-change-the-world/>; <http://www.forbes.com/sites/joeharpaz/2016/05/31/will-blockchain-become-the-internet-of-finance/#5dccc5a12712>; <http://bravenewcoin.com/news/imf-report-calls-bitcoins-blockchain-the-internet-of-trust/> (last visited April 25, 2017)

110. See <https://medium.com/the-intrepid-review/the-top-10-blockchain-startups-to-watch-in-2016-the-leaders-who-are-changing-the-game-6195606bod70#.mi8zmpuq>; <https://github.com/ethereum/wiki/wiki/White-Papers#further-applications> (last visited April 25, 2017)

111. https://www2.deloitte.com/content/dam/Deloitte/de/Documents/Innovation/Blockchain_A%20game-changer%20in%20accounting.pdf (last visited April 25, 2017)

112. <http://www.cnn.com/2016/05/09/schools-are-recording-students-results-on-the-blockchain.html>; <http://chainthat.com/education/> (last visited April 25, 2017)

113. <http://gridsingularity.com/> (last visited April 25, 2017)

114. <https://idcubed.org/chapter-10-green-coins-using-digital-currency-build-new-power-platform/> (last visited April 25, 2017)

115. <https://slock.it/solutions.html> (last visited April 25, 2017)

116. <https://github.com/jorisontje/moveth> (last visited April 25, 2017)

117. <https://medium.com/@ConsenSys/introducing-proof-of-physical-address-acf54fc95f21> (last visited April 25, 2017)

- v. Social networks: Ventures like Project Groundhog¹¹⁸ and Akasha¹¹⁹ seek to use the blockchain to divest power from centralized operators of social networks.
- vi. Social impact and political participation: Our founder, Nishith M. Desai, has been predicting direct democracy facilitated by technology for a quite a while. D-CENT is a Europe-wide project that uses the blockchain to facilitate direct democracy and economic empowerment by citizens, so they can *“be informed and get real-time notifications about issues that matter to them; propose and draft solutions and policy collaboratively; decide and vote on solutions and collective municipal budgeting”* and be rewarded under blockchain reward schemes.¹²⁰ This application of the blockchain was also suggested in the Ethereum white paper.¹²¹
- vii. Miscellaneous: Some other proposed applications are: decentralized organizations / “future of work” (Ethereum is already a sophisticated user of these);¹²² a notary service;¹²³ crowdsourcing;¹²⁴ an emergency reporting system;¹²⁵ a file storage system;¹²⁶ and a domain name registry.¹²⁷

118. <https://www.youtube.com/watch?v=WFfjYv3PSaI> (last visited April 25, 2017)

119. <http://akasha.world/> (last visited April 25, 2017)

120. <http://dcentproject.eu/> (last visited April 25, 2017)

121. <https://github.com/ethereum/wiki/wiki/White-Paper#applications> (last visited April 25, 2017)

122. <https://colony.io> (last visited April 25, 2017)

123. <https://github.com/maran/notareth> (last visited April 25, 2017)

124. <https://medium.com/the-crowdjury/the-crowdjury-a-crowdsourced-court-system-for-the-collaboration-era-66da002750d8> (last visited April 25, 2017)

125. <https://github.com/mizutaka/DAERS> (last visited April 25, 2017)

126. <https://github.com/ethereum/wiki/wiki/White-Paper#decentralized-file-storage> (last visited April 25, 2017)

127. <https://github.com/ethereum/wiki/wiki/White-Paper#identity-and-reputation-systems> (last visited April 25, 2017)

4. Regulatory Reaction

I. Early Days

Since blockchain technology only creates an *infrastructure* or medium enabling a variety of applications, it is yet to stir up much regulatory controversy in and of itself. This is as opposed to, say, Bitcoin, which was a specific application that disrupted traditional currency systems and had governments around the world scrambling to understand its legal consequences.¹²⁸ As a response to Bitcoin, some governments instituted licensing requirements for dealing in virtual currencies, such as the New York State Department of Financial Services' 'BitLicense' regime,¹²⁹ and some even went so far as to ban them.¹³⁰

II. Positive Indications; 'Regulatory Sandboxes'

As opposed to Bitcoin, most regulators' statements on blockchain technology have been positive.¹³¹ Led by the U.K., many countries including Australia, the U.S., Hong Kong, Malaysia, Singapore, Switzerland, Thailand, and United Arab Emirates have implemented or are exploring the idea of 'regulatory sandboxes' for blockchain (and other types of) innovation.¹³² Regulatory sandboxes allow organizations to experiment with innovative business models without fear of regulatory consequences,

as long as they meet certain consumer protection norms.¹³³

On a separate note, as mentioned previously, the governments of Canada, China, Japan, Netherlands, the U.K., and Sweden have all been reported to be exploring the issuance of digital versions of fiat currency on the blockchain.¹³⁴ This has also been mentioned in the Indian context, as explained below. Such government authorization will pave the way for the adoption of blockchain technology in mainstream financial transactions.

Further, as discussed in the previous section, the blockchain is receiving a lot of interest from governments for innovation in their own services.



Source: <https://www.fca.org.uk>

The U.K.'s Financial Conduct Authority is considered by the fintech industry as one of the most forward-thinking regulators worldwide.

III. Indian Response

In India, at the moment, there is no law or policy specifically addressing blockchain technology. In April 2017, an inter-disciplinary committee was set up by the Ministry of Finance, to be chaired by the Special Secretary (Economic Affairs) and representatives from various Central government departments, including the Department of Revenue (CBDT), Ministry of Electronics and Information Technology, the RBI, NITI Aayog, and State Bank of India, to examine the regulation of virtual currencies.¹³⁵ However, there may be a dichotomy in the government's

128. See sections 4-6 of our research paper on Bitcoin, available at <http://www.nishithdesai.com/information/research-and-articles/research-papers.html>. (last visited April 25, 2017)

129. <http://www.dfs.ny.gov/legal/regulations/adoptions/dfsp200t.pdf>; <http://www.coindesk.com/regulation/bitlicense/> (last visited April 25, 2017)

130. <http://www.coindesk.com/bolivias-central-bank-bans-bitcoin-digital-currencies/> (last visited April 25, 2017)

131. E.g., <https://www.finextra.com/blogposting/13055/blockchain-playing-in-the-regulatory-sandbox>; <http://www.coindesk.com/south-africas-central-bank-says-open-crypto-currencies/> (last visited April 25, 2017)

132. <https://www.americanexpress.com/uk/content/foreign-exchange/articles/regulatory-sandboxes-for-innovative-payment-solutions/> (last visited April 25, 2017)

133. *Id.*

134. https://www.bbvaesearch.com/wp-content/uploads/2016/12/WP_16-20.pdf (last visited April 26, 2017)

135. <http://pib.nic.in/newsite/PrintRelease.aspx?relid=160923> (last visited April 25, 2017)

approach to virtual currencies (which the government appears concerned about in light of the consumer protection risks) and blockchain technology as such (on which the government has expressed no negative view).

The Committee on Digital Payments, chaired by Mr. Ratan P. Watal, and constituted by the Ministry of Finance, in its December 2016 report cited an earlier version of this paper and noted the benefits of blockchain technology.¹³⁶

In addition, as mentioned previously, the IDRB has recommended that the “time is ripe” for the adoption of blockchain technology in India. The Government of Andhra Pradesh in October 2016 signed a FinTech Cooperation Agreement with the Monetary Authority of Singapore to “promote innovation in financial services in their respective markets[,], explore joint innovation projects on technologies such as digital payments and blockchain[,], collaborate on the development of education programmes/curricula on FinTech[,], and discuss emerging FinTech trends and exchange views on regulatory issues related to innovations in financial services.”¹³⁷

In addition, some regulatory officials have made press comments about blockchain technology, which have varied in tone. At a recent event, RBI Deputy Governor R.S. Gandhi in March 2017 said, “Blockchain, the foundation for bitcoins-like innovations, is touted to be the death knell of currency. I believe its potential is being overstated. We can see that in these types of solutions for virtual currency, there is no central bank or monetary authority. They pose potential financial, operational, legal, customer protection and security related risks.”¹³⁸ However, he added he was glad about the IDRB’s blockchain research project, and said, “There is a movement to make use of blockchain technology for virtual currency by the

central banks themselves. Of course, this calls for lot of research.”¹³⁹

In 2016, former Deputy Governor H. R. Khan had told reporters, “Blockchain is one thing that has come out of Bitcoin which provides a lot of flexibility in terms of financial transactions. So, we need to study... how this blockchain technology can be used in financial transactions where the entire data systems move to some more levels.”¹⁴⁰

IV. Uncertainty

However, since there is little legal authority on how blockchain technology will be treated, there is uncertainty in industry on this question. The thinking is that though the blockchain itself has not caused a regulatory stir, this does not guarantee that particular applications will not. On this note, the President of the Chamber of Digital Commerce, the world’s largest trade association representing the blockchain industry, and the World Federation of Exchanges, the global trade body for exchanges, have called for regulatory clarity over the use of blockchain technology for different purposes.¹⁴¹

In October 2016, the Digital Currency and Ledger Defense Coalition (DCLDC), a coalition of now 75 prominent U.S. lawyers and academics, was announced.¹⁴² The DCLDC seeks to protect the right of innovators experimenting with blockchain technology, through *pro bono* attorney referrals and the filing of amicus briefs.¹⁴³ Where regulatory sandboxes are not forthcoming, therefore, staying involved

¹³⁶ http://finmin.nic.in/reports/watal_report271216.pdf (last visited April 25, 2017)

¹³⁷ <http://www.mas.gov.sg/News-and-Publications/Media-Releases/2016/Singapore-and-the-Government-of-Andhra-Pradesh-ink-FinTech-cooperation-agreement.aspx> (last visited April 25, 2017)

¹³⁸ <http://www.coindesk.com/indian-central-banker-potential-blockchain-currencies-overstated/> (last visited April 25, 2017)

¹³⁹ *Id.*

¹⁴⁰ *Id.*

¹⁴¹ <https://www.forbes.com/sites/perianneboring/2016/06/28/the-blockchain-brain-drain-how-the-states-are-driving-blockchain-companies-abroad/#29b047e783fc> (last visited April 25, 2017); <http://www.reuters.com/article/us-exchange-regulations-blockchain-idUSKCN11017Q> (last visited April 25, 2017)

¹⁴² <http://www.the-blockchain.com/2016/10/03/40-us-law-firms-join-up-to-form-blockchain-legal-defense-coalition/> (last visited April 25, 2017)

¹⁴³ <http://www.dcldc.org/> (last visited April 25, 2017)

with industry bodies can be a powerful fallback for blockchain innovators.

V. Blockchain-Specific Regulatory Developments

At the time of writing,¹⁴⁴ there were only two regulatory actions specifically concerning blockchain technology (and not related to virtual currency) that we came across. A third, the Delaware Blockchain Initiative is said to be in the pipeline. All of these are discussed below.

A. U.K. Government Authorization of Blockchain E-Money Startup

In February 2017, the U.K. government granted the blockchain-based finance startup Tramonex a small Electronic Money Institution (EMI) registration.¹⁴⁵ The EMI registration is for persons who “issue e-money”, and “e-money” includes “*monetary value represented by a claim on the issuer that is stored electronically, including magnetically*”.¹⁴⁶ Tramonex’s website does not provide any description of how blockchain technology is involved in its offerings, but its website suggests that the solutions are related to traditional fiat currencies and not cryptocurrencies.¹⁴⁷ Tramonex offers to provide a “*single centralised payment hub [that] can reduce the cost of your banking infrastructure and increase efficiencies*” with the following solutions: working capital management, FX risk management, and operational management.¹⁴⁸

¹⁴⁴ April, 2017.

¹⁴⁵ <https://cointelegraph.com/news/uk-government-grants-permission-to-issue-blockchain-based-currency> (last visited April 26, 2017)

¹⁴⁶ <https://www.fca.org.uk/publication/archive/emoney-approach.pdf> (last visited April 26, 2017)

¹⁴⁷ <https://tramonex.com/#/home> (last visited April 26, 2017)

¹⁴⁸ *Id.*

B. French Government Order on Mini-bonds

In April 2016, the French government passed an order legislating rules surrounding ‘mini-bonds,’ a type of corporate debt instrument facilitating crowdfunding.¹⁴⁹ The order explicitly permits the issuance and transfer of mini-bonds using the blockchain, given certain adapted procedures and safeguards.¹⁵⁰ The order states that the registration of the sale transaction in the blockchain will operate as the transfer of title ownership.¹⁵¹ A working group is to determine detailed safeguards to ensure reliability, security, and the capacity to be audited.¹⁵² The order also contains the first known regulatory definition of the blockchain: a “shared electronic storage device” or “*a shared electronic recording system allowing for authentication*.”¹⁵³ As a result of this move, BNP Paribas announced in September 2016 that it would expand its blockchain platform to allow private companies to issue minibonds via crowdfunding platforms.¹⁵⁴

C. Delaware Blockchain Initiative

Delaware, the premier incorporation destination for American corporates, is aiming to introduce soon a regulatory change that “*will allow for the application of distributed ledger technology to many of the private sector’s most basic and critical legal documents, which companies currently file with the*

¹⁴⁹ <https://translate.google.com/translate?hl=en&sl=fr&u=https://www.legifrance.gouv.fr/eli/rapport/2016/4/29/FCPT1608300P/JO&prev=search> (translated report explaining the order); <https://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000032465520&categorieLien=id> (original text of order).

¹⁵⁰ *Id.*

¹⁵¹ *Id.*

¹⁵² *Id.*

¹⁵³ *Id.*

¹⁵⁴ <https://group.bnpparibas/en/press-release/bnp-paribas-securities-services-expands-blockchain-platform-private-stocks> (last visited October 3, 2016)

*Delaware Division of Corporations.*¹⁵⁵ Significantly, this change proposes to move shares to the blockchain. As a result, the proponents of the initiative claim: investors and issuers would interact directly, ownership rights would be clear, capitalization table management would become easy, proxy voting would be transparent and accurate, dividends and corporate actions like stock splits would be automated and accurate, and accidental over-issue of securities would never happen. To delve into a little more technical detail,

When a company chooses to incorporate in Delaware using distributed ledger shares, the Division of Corporations could validate and file

*the incorporation plus transfer the authorized shares to the new company. Only shares that are cryptographically “signed” and transferred by the Division of Corporations, in that genesis transaction for the new company, would be considered validly-authorized distributed ledger shares []. By doing this, the Division of Corporations establishes a perfect record of authorized shares, and the distributed ledger can then track shares that are issued and outstanding.*¹⁵⁶

This is a significant move that is a classic case of capitalizing on the unique features of the blockchain.

¹⁵⁵<https://corpgov.law.harvard.edu/2017/03/16/delaware-block-chain-initiative-transforming-the-foundational-infrastructure-of-corporate-finance/> (last visited April 26, 2017). The original text of the proposal is available at [http://www.rlf.com/files/14257_Council%202017%20Proposals%20in%20Bill%20Form%20\(5\).pdf](http://www.rlf.com/files/14257_Council%202017%20Proposals%20in%20Bill%20Form%20(5).pdf) (last visited April 26, 2017).

¹⁵⁶*Id.*

5. Forecasting Legal Issues

Despite the lack of legal authority on blockchain technology to date, there are several interesting legal questions which it raises and should be considered. In general, however, analyzing the legal implications of the blockchain outside of a particular use case is less straightforward than the same analysis of Bitcoin. This is because Bitcoin is only one specific use case of blockchain technology, whereas blockchain technology can be applied in almost any context.

I. Pseudonymity and Legal Enforcement

A lot of people still associate Bitcoin with nefarious activities on the 'dark web,' like illegal purchases of banned substances and guns, and financing terrorism.¹⁵⁷ This is because network participants could be anonymous or pseudonymous i.e., not fully anonymous – because of various identifying information like network (IP) addresses and public keys – but not obviously linked to a real identity.¹⁵⁸ In this aspect, the blockchain operates with the same properties as Bitcoin. Therefore the question arises about how regulators and counterparties will hold participants accountable, and enforce legal, tax, and contractual obligations.¹⁵⁹ Albeit a tangential example, the enormous amount of resources it took for the U.S. Federal Bureau of Investigation (FBI) to trace the mastermind behind 'Silk Road' (the infamous 'dark web' exchange) bears testimony to this.¹⁶⁰ Further, when the blockchain is deployed in regulated industries, KYC requirements and various reporting obligations like anti-

money-laundering and anti-terrorist-financing (depending on the jurisdiction) are triggered. These will be hard to meet when transactions are on blockchains, at least in the form that blockchains are commonly used today.¹⁶¹

The likely solution to this is the requirement that participants must shed their anonymity/pseudonymity on the blockchain for commercial transactions. This is something that lawmakers could address. The Indian Information Technology Act, 2000 (“**IT Act**”) could, for instance, be amended to this effect. There are already technical solutions that facilitate this.¹⁶² In addition, 'private' or 'permissioned' blockchains, which, as opposed to 'public' or 'permissionless' blockchains (like Bitcoin), regulate who can access the blockchain network and how they can participate in it. This is usually an important feature of the various enterprise blockchain solutions on the market. The Chain Protocol, the blockchain protocol targeted at financial institutions and discussed previously, is an example of a permissioned blockchain.¹⁶³

II. Privacy and Cybersecurity

A. Privacy

The counterpoint to the pseudonymity-based legal issues is that because blockchain participants cannot be fully anonymous and the distributed ledger is publicly viewable, there are privacy implications.¹⁶⁴ As mentioned, blockchain participants can be identified using their public keys and IP addresses, among other identifiers, and every transaction can be

157. *E.g.*, <http://www.coindesk.com/google-search-study-hints-shady-truth-bitcoin-users/> (last visited April 25, 2017)

158. <http://gizmodo.com/a-friendly-reminder-bitcoin-is-not-anonymous-1682885318> (last visited April 25, 2017)

159. <http://www.lexology.com/library/detail.aspx?g=bc1e03ba-1800-4bfb-8e13-1826e9d2733f>; http://www.weblaw.co.uk/ebooks/eGuide_BlockchainTheConceptandtheLaw.pdf (last visited April 25, 2017)

160. <http://www.usatoday.com/story/news/nation/2013/10/21/fbi-cracks-silk-road/2984921/> (last visited April 25, 2017)

161. <http://www.lexology.com/library/detail.aspx?g=bc1e03ba-1800-4bfb-8e13-1826e9d2733f> (last visited April 25, 2017)

162. *E.g.*, <http://www.blockchainme.com/index.html> (last visited April 25, 2017)

163. <https://news.bitcoin.com/chain-open-standard-1-goes-public/> (last visited April 25, 2017)

164. <http://www.lexology.com/library/detail.aspx?g=e1e10aaf-3447-4088-81dd-7521244fecb3>; http://www.weblaw.co.uk/ebooks/eGuide_BlockchainTheConceptandtheLaw.pdf (last visited April 25, 2017)

seen by every participant (this is an essential feature of blockchain technology). Since the blockchain is a new technology, most existing privacy laws around the world, including the Indian IT Act, would not contemplate privacy protections for blockchain participants in this sense.¹⁶⁵ Most Internet privacy laws deal with a situation where a website/app collects personal information from an end user. The IT Act, for instance, regulates the collection, use, and disclosure of sensitive personal data or information by a body corporate which owns, controls or operates a computer resource.¹⁶⁶ So though participants would have these ordinary Internet privacy rights, such rights will likely not extend to the blockchain because there is no centralized organization collecting information. If we look at the IT Act's language (section 43A), privacy on the blockchain would likely not be available because there is no single "body corporate" collecting user information and "own[ing], control[ling] or operat[ing]" a computer resource (unlike a regular web service does, for instance). Rather, information is shared with all blockchain participants, and control is decentralized. Enterprise deployments of commercial blockchain technology might therefore look to address these privacy concerns,¹⁶⁷ incorporating privacy by design. While doing so, however, they should also look to preserve accountability, for reasons discussed in the previous section. Lawmakers could look at mandating that blockchain operators (in situations where there are centralized operators) incorporate such a dual-edged feature, if technically feasible.

B. Cybersecurity

If high value transactions and records are going to be moved to the blockchain – which seems likely, as the earlier discussion of industry appli-

cations showed – cybersecurity becomes essential.¹⁶⁸ Data breaches are being announced every day, and the 2016 Ethereum DAO hack shows that the implementation of blockchain technology is not infallible (even though the underlying technology is widely acknowledged to be robust and secure). For instance, participants' private keys (stored on their devices and/or on the cloud) can unlock their entire holdings, making private keys a definite target,¹⁶⁹ and often a 'single point of failure.'¹⁷⁰ This risk has already materialized several times with Bitcoin.

Existing laws, including the requirements under the IT Act and the Information Technology (Reasonable security practices and procedures and sensitive personal data or information) Rules, 2011, will govern blockchain activity since the blockchain is an Internet-based system. But these requirements do not easily fit with the nature of the blockchain. As mentioned above, with the blockchain, there is usually no controlling "body corporate" to pin accountability for cybersecurity to. Where there are blockchain operators, they will be held to the cybersecurity requirements of the Rules.

But because the system is decentralized, and because there are not always any centralized 'operators' (as with Bitcoin), this is not enough to ensure cybersecurity. Further, existing standards on data protection, such as the IS/ISO/IEC 27001 standard that the Rules mention, may not suffice for the blockchain, because they were not designed keeping in mind its decentralized nature. As we speak, however, new cybersecurity standards tailored to the blockchain are being conceived,¹⁷¹ and such standards will have to be referenced into existing law.

¹⁶⁵ <http://www.lexology.com/library/detail.aspx?g=ee10a0af-3447-4088-81dd-7521244feb3> (last visited April 25, 2017)

¹⁶⁶ Section 43A, IT Act, read with the Information Technology (Reasonable security practices and procedures and sensitive personal data or information) Rules, 2011. (last visited April 25, 2017)

¹⁶⁷ http://www.weblaw.co.uk/ebooks/eGuide_BlockchainThe-ConceptandtheLaw.pdf (last visited April 25, 2017)

¹⁶⁸ <http://www.lexology.com/library/detail.aspx?g=ee10a0af-3447-4088-81dd-7521244feb3> (last visited April 25, 2017)

¹⁶⁹ *Id.*

¹⁷⁰ See e.g., this explanation by Vitalik Buterin, a co-founder of Ethereum: <https://www.youtube.com/watch?v=UFDA1StVXbc>. (last visited April 25, 2017)

¹⁷¹ <https://www.w3.org/2016/04/blockchain-workshop/report.html> (last visited April 25, 2017)

III. Complications Associated with Decentralized Autonomous Organizations (DAOs)

“A DAO is a virtual autonomous organization, in which the functions of the organization exist in software, and the laws governing the organization’s functions are set into smart contracts that become automatically enforceable if a set of defined conditions are met. As a result, the DAO becomes a company that runs by itself, without a centralized governing body.”¹⁷²

The most well-known example of a DAO is ‘The DAO’ (mentioned earlier), an organization functioning on the Ethereum blockchain, and which had collected a pool of cryptocurrency worth several million U.S. dollars as crowdfunding for venture capital investment purposes.¹⁷³

Being of such a decentralized, pseudonymous nature, DAOs do not fit within existing definitions of legal entities like companies and partnerships.¹⁷⁴ This is because stakeholders in DAOs may not necessarily agree with the distribution of decision-making power, and the responsibilities of directors, shareholders, partners, and employees, dictated by these traditional structures. In a DAO, as the name suggests, authority is thoroughly decentralized, with decision-making often driven purely by consensus.¹⁷⁵ Further, they are not ‘located’ within any particular jurisdiction (they are

considered ‘stateless’),¹⁷⁶ so the applicable law is itself a question.¹⁷⁷ The nature of their members’ ‘interest’ in them is also unclear (as opposed to a company share or partnership stake).¹⁷⁸ These make it hard to answer how a DAO’s or its members’ legal rights and duties would be considered.

It is not easy to simply create an artificial regulatory definition for a DAO, because they are governed and operated by software code, and the organizational rules can be written in a limitless number of ways. Another question worth considering is to what extent the programmers of the code underlying the DAO be accountable for its actions and for security breaches of its architecture.¹⁷⁹

These theoretical difficulties become clearer to visualize when one thinks of the recent multimillion dollar hack of the Ethereum DAO, discussed previously.¹⁸⁰ The applicable law, the legal recourse for the DAO’s investors, the development of a suitable insurance regime for such situations, the liability of the DAO’s programmers, and the regulation of DAOs as investment vehicles make for difficult questions in such a situation.¹⁸¹ This is in addition to the difficulty of pinning down responsibility due to anonymity/pseudonymity and decentralization. At the time of writing,¹⁸² the persons responsible for the hack of the Ethereum DAO were still unknown. No member or software developer within that DAO could be faulted either, because the code was open-source, hence making everyone (and no one) responsible

172. <https://www.tractica.com/automation-robotics/blockchain-daos-and-the-future-of-government/> (last visited April 25, 2017)

173. <http://fortune.com/2016/05/15/leaderless-block-chain-vc-fund/> (last visited April 25, 2017)

174. http://www.clydeco.com/uploads/Files/CC010565_Blockchain_brochure_10-06-16_LOWRES.PDF; but see <http://bollier.org/sites/default/files/misc-file-upload/files/DistributedNetworksandtheLaw%20report,%20toSwarm-Coin%20Center-Berkman.pdf> suggesting possible legal organizational structures within which DAOs could fall. (last visited April 25, 2017)

175. <https://medium.com/@Blockchain/what-is-a-dao-how-do-they-benefit-consumers-f7a0a862f3dc#.g8br19tqk> (last visited April 25, 2017)

176. <http://www.economist.com/news/finance-and-economics/21699159-new-automated-investment-fund-has-attracted-stacks-digital-money-dao> (last visited April 25, 2017)

177. http://www.clydeco.com/uploads/Files/CC010565_Blockchain_brochure_10-06-16_LOWRES.PDF (last visited April 25, 2017)

178. *Id.*

179. <http://www.clydeco.com/insight/article/etheriums-dao-attacks-smart-contracts-and-blockchain-face-their-first-big-te> (last visited April 25, 2017)

180. <http://fortune.com/2016/06/18/blockchain-vc-fund-hacked/> (last visited April 25, 2017)

181. <http://www.clydeco.com/insight/article/etheriums-dao-attacks-smart-contracts-and-blockchain-face-their-first-big-te> (last visited April 25, 2017)

182. April, 2017.

for its robustness. The legal concept of an ‘association of persons’ may be a useful starting point for the legal analysis of DAOs. Under Indian law, an association of persons is a body of individuals or legal entities which associate themselves to further a common purpose.¹⁸³

Other than interpretation of the broad concept by courts, there are no legal strictures – as there are for companies and partnerships – surrounding this concept. This provides DAOs with a significant degree of legal flexibility to be governed as their members decide. At the same time, laws such as the Income Tax Act, 1961 and the Competition Act, 2002, recognize the concept of an ‘association of persons,’ hence preventing DAOs from ‘slipping under the radar’ and being considered nefarious.

IV. Complications due to Immutability and Irreversibility

Blockchains cannot be ‘edited’ like conventional ledgers. Once transactions are recorded, they remain in the universal ledger unless every participant agrees otherwise.¹⁸⁴ In one sense, the only editors are cryptography and the ‘wisdom of the crowd’. This has led some to point out that immutability is “[t]he most obvious risk inherent in blockchain technology.”¹⁸⁵ This is because while immutability preserves the integrity of transactions, it may become problematic when untrustworthy users have managed to conceal fraud.¹⁸⁶ In an ordinary situation, the defrauded parties could approach courts, regulatory bodies (in India, one could approach the RBI under the Banking Ombudsman Scheme), or third party gatekeepers (like banks) to either (a) reverse the fraud, or (b) receive compensation.¹⁸⁷

183. <http://www.financialexpress.com/archive/legal-concept-of-association-of-persons/372324/>; C.I.T. v. Indira Balkrishna, 39 ITR 546. (last visited April 25, 2017)

184. http://www.weblaw.co.uk/ebooks/eGuide_BlockchainTheConceptandtheLaw.pdf (last visited April 25, 2017)

185. *Id.*

186. *Id.*

187. *Id.*

In blockchain transactions, however, (a) fraudulent transactions cannot be reversed by any central party, and (b) it is difficult for courts to trace the wrongdoer, and even if they do, to enforce a judgment, for reasons discussed under sub-section I. above (“**Pseudonymity and Legal Enforcement**”).¹⁸⁸ It is likely that enterprise deployments of blockchain technology will, through private/permissioned systems, look to tackle these problems. Otherwise, banks and payment system operators using the blockchain may find themselves (in some cases) in violation of the detailed regulatory requirements governing them – such as, in India, those under the Banking Regulation Act, 1949, and the Payment and Settlement Systems Act, 2007.

So that innovation is not unnecessarily impeded, regulators may consider mandating a workaround that does not compromise the decentralization and permanence that is unique to the blockchain, but holds some possibility for ‘corrections’ to the ledger if certain conditions are met.

V. Jurisdictional Questions

The Internet itself has raised several questions on how to decide when a given jurisdiction’s law would govern a given situation. For example, Indian courts will look at whether a website was made available in the country “with an intention to conclude a commercial transaction” with Indian users.¹⁸⁹ In the case of an ultra-decentralized technology like the blockchain, the difficulty of these questions is amplified.¹⁹⁰ This is because there are no identifiable ‘hosts’ or ‘operators’ as there are for ordinary websites and apps (even if there is an identifiable blockchain operator, its role would likely be very different from a website/app operator’s). This makes identifying legal responsibility difficult, as discussed above. In addition, servers for each blockchain network

188. *Id.*

189. *Banyan Tree Holding Pvt. Ltd. v. A. Murali Krishna Reddy & Anr.*, 2008 (38) PTC 288 (Del) (last visited April 25, 2017)

190. http://www.clydeco.com/uploads/Files/CCo10565_Blockchain_brochure_10-06-16_LOWRES.PDF (last visited April 25, 2017)

are decentralized and likely spread throughout the world, making it difficult to pinpoint where a breach or failure occurred.¹⁹¹

In the case of the Internet generally, several jurisdictions have mandated some form of data localization or border controls, where servers are required to be kept in that jurisdiction (e.g., Russia) or there are restrictions on how data can flow out of the jurisdiction (e.g., the EU and India). For the blockchain, lawmakers will have to consider how their jurisdictions' technology laws apply. A multi-stakeholder, global approach appears to be best, to ensure the harmony of international rules. In this vein, associations like the Chamber of Digital Commerce and the Digital Currency and Ledger Defense Coalition have garnered wide participation and are likely to play an important role.

VI. Contract Law Grey Areas

As discussed previously, a key feature of the blockchain is the “*formation and execution of digital contracts*.”¹⁹² In other words, instead of ordinary human language, software code dictates parties' rights and responsibilities, and automatically executes when specified conditions are met. This could be for the entirety of the contract or only in certain provisions. Contract law around the world is based on human decisions and judgment (e.g., the treatment of offer and acceptance, meeting of the minds, and consideration).¹⁹³ Therefore, automatic execution and machine language create new legal questions:

- Are these digital contracts “contracts” as seen by the law?
- Can they be enforced and parties be held responsible in the same way as traditional contracts?

191. *Id.*

192. <http://www.lexology.com/library/detail.aspx?g=bce03ba180-4bfb-8e13-1826e9d2733f> (last visited April 25, 2017)

193. http://www.clydeco.com/uploads/Files/CC010565_Blockchain_brochure_10-06-16_LOWRES.PDF (last visited April 25, 2017)

- What if the code underlying these digital contracts is hacked?

Commentators have given the example of parties not being able to plead duress or mistake of fact in a real estate transaction because all changes in ownership and the status of the property would have already been verified and recorded in a universally accessible blockchain.¹⁹⁴ They have also noted that the ‘volition’ element in law, where parties’ choice of action gains importance, may not suit blockchain transactions, since actions – such as the filing of a lawsuit upon default – automatically execute.¹⁹⁵ (One could argue, however, that volition occurred at the time the digital contract was drafted.) Also, due to immutability and irreversibility, as mentioned above, remedies for smart contracts ‘gone wrong’ (e.g., mistaken rainfall data in the context of a drought insurance contract)¹⁹⁶ may be difficult to pursue, since traditional contract law options like rescission will not be viable.¹⁹⁷ Because of immutability and irreversibility, arguments for unenforceability that fall outside those situations contemplated by the written code (e.g., fraud, force majeure, and frustration) may become harder to resolve than usual.¹⁹⁸

To help resolve such contractual ambiguities, some have suggested that there should be natural language contracts signed, complementing the digital contracts (e.g., a Master Supply Agreement that governs all the smart contract purchase orders), that enable the parties to resolve such situations under traditional contract law mechanisms.¹⁹⁹ Whether through this way or another, the

194. <http://www.lexology.com/library/detail.aspx?g=bce03ba180-4bfb-8e13-1826e9d2733f>; <http://www.lexology.com/library/detail.aspx?g=e10aaf-3447-4088-81dd-7521244fecb3> (last visited April 25, 2017)

195. <http://www.lexology.com/library/detail.aspx?g=e10aaf-3447-4088-81dd-7521244fecb3> (last visited April 25, 2017)

196. <http://www.clydeco.com/insight/article/arbitrating-blockchain-disputes-will-smart-contracts-require-smart-dispute> (last visited April 25, 2017)

197. http://www.weblaw.co.uk/ebooks/eGuide_BlockchainTheConceptandtheLaw.pdf (last visited April 25, 2017)

198. <http://www.clydeco.com/insight/article/smart-contracts-where-law-meets-technology> (last visited April 25, 2017)

199. *Id.*

practical solution appears to be to retain a natural language contractual element at least until the legal system, parties, and lawyers are familiar with smart contracts. It is also essential that, because of the murky legal issues discussed in this section, blockchain contracts have detailed dispute resolution clauses in which the parties legislate for various outcomes specifically taking into account the technology,²⁰⁰ hence avoiding confusion later.

Digital/smart contracts raise the question of the role of lawyers in transactional practice going forward. This is of course even more relevant in the light of the rapid strides in artificial intelligence. The reasonable view is that lawyers will still be required to draft non-obvious contractual terms or terms that cannot fit into technical language; interact with programmers on the correspondence between the natural language and software code;²⁰¹ and counsel parties on legal risks. Many have pointed out that a working understanding of software programming will be very useful for the next generation of lawyers.²⁰² While regulation should not be imposed hastily, it is likely that as smart contracts come into use, new contract law rules are necessary to govern code-based and blockchain-driven contracts.²⁰³

VII. Whether Blockchain Tokens are ‘Securities’

Transactions occur on the blockchain through the exchange of tokens. In the case of the Bitcoin blockchain, the tokens stand for Bitcoin value, but tokens can be configured to represent

anything that can be transacted (e.g., real estate or company shares.)

As we discussed in Section 3(III) (“**Applications**”), securities and derivatives are a major potential application of blockchain technology. The question of how blockchain tokens fall within existing definitions of ‘securities’ and ‘derivatives’ therefore becomes relevant. In our paper on Bitcoins,²⁰⁴ we concluded that Bitcoins could not be classified either as ‘securities’ or ‘derivatives’ under the Securities Contracts (Regulation) Act, 1956 (“**SCRA**”). This is because Bitcoins do not have an underlying asset, and are not “issued” by any particular entity.

When analyzing blockchain tokens in general, the analysis is more context-specific. This is because while Bitcoins only represent virtual currency, nearly anything can be represented on the blockchain. A recent publication by the Coinbase, Coin Center, Union Square Ventures, and Consensus, in partnership with the U.S. law firm Debevoise & Plimpton, aimed to establish a securities law framework for blockchain tokens under U.S. law.²⁰⁵ It established a mechanism for entities to “estimate how likely a particular token is to be a security” under U.S. law. This mechanism is a step-by-step process leading to a score, which is meant to act as a risk assessment. The publication also sets out best practices for ‘crowdsales’ of tokens. Finally, it contains an analysis by Debevoise & Plimpton which concludes, “*an appropriately designed Blockchain Token that consists of rights and does not include any investment interests should not be deemed to be a security, subject to the specific facts, circumstances and characteristics of the Blockchain Token itself. Rather, given our analysis in the above, it should be characterized as a simple contract, akin to a franchise or license agreement.*” An earlier publication by several well-known thinkers on blockchain technology (some of whom also participated in the previously mentioned

200. <http://www.clydeco.com/insight/article/arbitrating-blockchain-disputes-will-smart-contracts-require-smart-dispute> (last visited April 25, 2017)

201. http://www.weblaw.co.uk/ebooks/eGuide_BlockchainTheConceptandtheLaw.pdf (last visited April 25, 2017)

202. Richard Susskind, *Tomorrow’s Lawyers: An Introduction to Your Future* (Oxford University Press, 2013); http://www.weblaw.co.uk/ebooks/eGuide_BlockchainTheConceptandtheLaw (http://www.weblaw.co.uk/ebooks/eGuide_BlockchainTheConceptandtheLaw); <http://www.lexology.com/library/detail.aspx?g=bc1e03ba-1800-4bfb-8e13-1826e9d2733f> (last visited April 25, 2017)

203. <http://www.clydeco.com/insight/article/smart-contracts-where-law-meets-technology> (last visited April 25, 2017)

204. Latest draft available at <http://www.nishithdesai.com/information/research-and-articles/research-papers.html>. (last visited April 25, 2017)

205. <https://www.coinbase.com/legal/securities-law-framework.pdf> (last visited April 26, 2017)

publication) also undertook a detailed analysis of how blockchain tokens would fall within the 'securities' definition under U.S. law.²⁰⁶

Its conclusion was that the answer would change depending on what the token represented. Analyzing different hypothetical tokens, the working paper concluded that tokens representing: access to a software product which may appreciate in value; voting rights with a financial concern; and ownership of digital assets without an expectation of profit, may generally be considered securities. Tokens representing non-transferable software access rights; voting rights without a financial concern; digital goods without an expectation of profit; and 'shares' in DAOs were not likely to be considered securities. In the Indian context, the analysis will have to be made primarily with regard to the 'underlying asset' and 'issuance' requirements.

VIII. Adaptations of Older Requirements

Existing law has a swathe of procedural requirements governing commercial transactions and political processes, including (in India):

- The requirement of physical signatures, notarization, stamping, and registration for specified classes of documents (e.g., real property conveyances) under various laws;
- Formalities for assignment under intellectual property laws;
- The IT Act's stipulations on electronic signatures;
- The process for voting under the Representation of the People Act, 1951, and the Companies Act, 2013;

- Share issuance and transfer procedures under the Companies Act, 2013, and the Foreign Exchange Management Act, 1999;
- Maintenance of records and registers under various laws including the Companies Act, 2013, the Limited Liability Partnership Act, 2008, and the Partnership Act, 1932;
- Securities transactions regulations under the SCRA, and forward contracts regulation under the Forward Contracts (Regulation) Act, 1952;
- Payment and settlement system requirements under the Payment and Settlement Systems Act, 2007; and
- Detailed banking and finance regulations under the Banking Regulation Act, 1949, the Recovery of Debts Due to Banks and Financial Institutions Act, 1993 (commonly known as the 'Debt Recovery Act'), and the Securitisation and Reconstruction of Financial Assets and Enforcement of Security Interest Act, 2002 (commonly known as 'SARFAESI').

Many of these requirements will struggle to be satisfied by the blockchain because of its electronic, trustless, and decentralized nature. As blockchain technology gains ground in India, lawmakers can consider a legislation relaxing procedural requirements that impede its progress (hence impeding innovation). These requirements may have been suitable for an older way of doing things but will likely be obviated by the unique features of the blockchain. The French government's order on mini-bonds, discussed earlier, is a good example of a regulation expressly enabling the use of the blockchain.

²⁰⁶<http://bollier.org/sites/default/files/misc-file-upload/files/DistributedNetworksandtheLaw%20report%2C%20Swarm-Coin%20Center-Berkman.pdf> (last visited April 26, 2017)

6. Practical Challenges

The blockchain is fascinating in theory, but some consider it overhyped.²⁰⁷ They believe that the numbers on its funding, manpower, and adoption do not live up to the many ambitious estimates of its potential.²⁰⁸

The following are some challenges that it will have to face if it is to reach its predicted success:

I. Cybersecurity

Bitcoin exchanges and participants have been subjected to security breaches numerous times, including a recent August 2016 hack of the exchange Bitfinex, resulting in losses amounting to about USD 72 million.²⁰⁹ The recent Ethereum DAO hack proves that vulnerabilities can exist outside of the Bitcoin implementation of blockchain technology too.

Though the fundamental technology underlying the blockchain has rarely been questioned on security grounds, the implementation by participants, exchanges, and DAOs has sometimes not been watertight. One security weakness at a more fundamental level is the importance attached to participants' private keys: some have stated, "[p]ermanent loss of a private encryption key would be a lot like loss of life."²¹⁰

Organizations may thus face a security v. cost tradeoff that "either means your blockchain is cheap but risky or expensive and secure."²¹¹

207. <https://www.bloomberg.com/gadfly/articles/2016-09-08/blockchain-s-ambitions-thwarted-by-funding-hype/>; <http://www.coindesk.com/reached-peak-blockchain-hype/> (last visited April 25, 2017)

208. *Id.*

209. <http://www.coindesk.com/bitcoin-price-bruised-bitfinex/> (last visited April 25, 2017)

210. <http://www.lexology.com/library/detail.aspx?g=ee10aaf-3447-4088-81dd-7521244feb3> (last visited April 25, 2017)

211. <http://www.businessinsider.com/credit-suisse-on-the-challenges-for-blockchain-going-mainstream-2016-8> (last visited April 25, 2017)

II. Widespread Adoption

Mr. A. P. Hota, CEO and Managing Director of India's NPCI, remarked after a blockchain event, "[w]hile it was clear that the technology is radical, unless the entire ecosystem moves toward it, it is hardly of any significance."²¹² This can be easily understood when we consider that the value of Bitcoins is only existent because people are willing to trade currency/goods/services for them. A Bitcoin network of a few people would be of little consequence. Credit Suisse has also pointed out that "critical mass" is essential for the blockchain's success, and that players like R3 (through the initiatives and partnerships discussed previously) are making positive steps towards this.²¹³ However, the inertia of established systems (and the integration of the blockchain with them); skepticism towards Bitcoin and the blockchain as 'rebel' systems; and the high cost of a sophisticated blockchain deployment may be challenges to widespread adoption.²¹⁴

III. Necessity

The question arises why established industries and processes should break a working status quo and use the blockchain.²¹⁵ This is the case when as in banking services, the blockchain's features do not easily support some processes taken for granted today, such as chargebacks/refunds by banks after fraudulent transactions. According

212. <http://timesofindia.indiatimes.com/business/india-business/Next-Banking-Disruption-Lies-In-One-Open-Online-Ledger/articleshow/54318646.cms> (last visited April 25, 2017)

213. <http://www.businessinsider.com/credit-suisse-on-the-challenges-for-blockchain-going-mainstream-2016-8> (last visited April 25, 2017)

214. <http://www2.deloitte.com/nl/nl/pages/innovatie/artikelen/blockchain-technology-9-benefits-and-7-challenges.html>; http://www.clydeco.com/uploads/Files/CC010565_Blockchain_brochure_10-06-16_LOWRES.PDF (last visited April 25, 2017)

215. <http://www.businessinsider.com/credit-suisse-on-the-challenges-for-blockchain-going-mainstream-2016-8> (last visited April 25, 2017)

to Credit Suisse, blockchain technology will only be useful in a particular application if parties “(1) require a database, (2) need shared write access, (3) have unknown writers whose interests are not unified, and (4) not trust a third party to maintain the integrity of the data.”²¹⁶ Organizations should therefore look beyond the excitement and carefully assess whether the blockchain is suitable and can adapt to their needs.

IV. Teething Problems

Many have acknowledged that the blockchain is a nascent technology, and its applications outside Bitcoin are still largely untested.²¹⁷ Some experts, while positive about the technology, give it 10 to 20 years to become mainstream.²¹⁸ Aspects such as the speed of transactions, the process of verification, and data limits therefore still have to find their ‘sweet spot’ in non-Bitcoin applications.²¹⁹

V. Privacy

The transparency that is essential to the blockchain, combined with the ability to trace participants’ real identities, can lead to serious privacy implications (see the previous section’s discussion of this issue).²²⁰

VI. Uncertain Regulatory Status

As mentioned previously, the World Federation of Exchanges lamented the lack of regulatory clarity on blockchain technology. This opinion is echoed widely,²²¹ and is supported by the various uncertainties discussed in the previous section.

VII. Energy Consumption

Some have also drawn attention to the substantial energy consumption by blockchain networks, because of the computationally intensive process of mining/verification.²²²

²¹⁶ *Id.*

²¹⁷ <http://www2.deloitte.com/nl/nl/pages/innovatie/artikelen/blockchain-technology-9-benefits-and-7-challenges.html>; <http://www.businessinsider.com/credit-suisse-on-the-challenges-for-blockchain-going-mainstream-2016-8>; http://www.clydeco.com/uploads/Files/CCo10565_Blockchain_brochure_10-06-16_LOWRES.PDF (last visited April 25, 2017)

²¹⁸ <http://www.coindesk.com/blockchain-decade-away-mainstream/> (last visited April 25, 2017)

²¹⁹ <http://www2.deloitte.com/nl/nl/pages/innovatie/artikelen/blockchain-technology-9-benefits-and-7-challenges.html> (last visited April 25, 2017)

²²⁰ *Also see id.*; <http://www.businessinsider.com/credit-suisse-on-the-challenges-for-blockchain-going-mainstream-2016-8> (last visited April 25, 2017)

²²¹ *E.g.*, <http://www2.deloitte.com/nl/nl/pages/innovatie/artikelen/blockchain-technology-9-benefits-and-7-challenges.html> (last visited April 25, 2017)

²²² *Id.*

7. Conclusion

Like any new technology or business model, the blockchain brings along with its benefits a host of legal, strategic, and operational challenges. As lawyers, we foresee several legal grey areas that could arise as a result of the blockchain being deployed in the various industries that it has applications in. However, we would not recommend hasty regulation of this technology, since it is complex and calls for time and effort to be put into understanding its implications. A rushed job is likely to impede innovation. At the same time, left unregulated, courts, adjudicators, and commercial parties will be left trying to

fit square pegs into round holes to understand how the technology fits within existing legal rules. A measured approach to regulation, that clarifies ambiguities where necessary, would hence be ideal. In this connection, the recent experimentation with the technology by industry and government in India; the multi-stakeholder coalitions worldwide to protect blockchain innovation and develop standards; and the development of regulatory sandboxes are good first steps.

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Our forte includes innovation and strategic advice in futuristic areas of law such as those relating to Bitcoins (block chain), Internet of Things (IOT), Aviation, Artificial Intelligence, Privatization of Outer Space, Drones, Robotics, Virtual Reality, Med-Tech, Ed-Tech and Medical Devices and Nanotechnology.

We specialize in Globalization, International Tax, Fund Formation, Corporate & M&A, Private Equity & Venture Capital, Intellectual Property, International Litigation and Dispute Resolution; Employment and HR, Intellectual Property, International Commercial Law and Private Client. Our industry expertise spans Automobile, Funds, Financial Services, IT and Telecom, Pharma and Healthcare, Media and Entertainment, Real Estate, Infrastructure and Education. Our key clientele comprise marquee Fortune 500 corporations.

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