Strategic Report

To the State of North Carolina

The North Carolina Blockchain Initiative is established under the supervision of the Office of the Lieutenant Governor of North Carolina Dan Forest, to research and understand blockchain, and its potential economic impact on the workforce and government of the State of North Carolina.

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Overview

Blockchain, now a near-household name, conjures images ranging from secretive cyber-punks to digital money. In reality, it is a technological advancement of something very mundane—a ledger. (Blockchain is also referred to as DLT or Digital Ledger Technology.) Ledgers have revolutionized society. (Indeed, there is strong evidence that writing was developed by the ancient Sumerians for the purpose of counting items.) Today, whether we realize it or not, ledgers rule our life. They are the backbone of all the wealth accumulation in society from bank accounts, to stocks, to real estate records, to social media platforms. Ledgers are also a fundamental enabler of the global growth that has accompanied the improvement of life throughout the world.

Blockchain In Under 1 Minute

Blockchain is a virtual ledger that exists simultaneously, in many places at once, on the computers of individuals (nodes) who collectively maintain the ledger, making blockchain decentralized. The simultaneous existence of many nodes removes the need for a "middleman" and enhances security. In addition, because the blockchain ledger exists simultaneously on all the nodes, blockchains are difficult to hack. When each block is created, a fingerprint (or hash) is generated connecting and further securing the integrity of the blockchain. The blockchain can also be made publicly available because most use a publicly facing anonymous address that generates a private key required to access the anonymous public address, creating a near-perfect audit trail. In addition, the algorithm that creates a public address, private key, and the hash is secured by cryptography, adding to the security of the blockchain.

How Blockchain and Its Regulation Can Make North Carolina an Economic Powerhouse

The technological improvement that blockchain brings to tasks that range from digital money to voting has captured the imagination of investors, innovators, engineers, and governments. And, while unfortunate, the COVID-19 pandemic has demonstrated that our society has made significant progress with digital platforms and that these platforms are not only convenient but necessary. Supporting the digital economy by focusing on blockchain can propel economic growth in North Carolina and further drive interest and investment in our state. Below, we recommend a staged approach that North Carolina can take to adopt and promote the development and implementation of blockchain technology to further press the advantages and benefits to this great state.

The North Carolina Blockchain Initiative

Formed in 2019 by Lieutenant Governor Dan Forest, the North Carolina Blockchain Initiative was established to study the unique attributes and use-cases of blockchain technology, digital assets, smart contracts, and digital tokens.

North Carolina has been a leader in innovation; in 2016, the state became an early mover on blockchain legislation, passing into law House Bill 289 that expanded the state's Money Transmitters Act to cover activities related to bitcoin and other cryptocurrencies. But more can be done with blockchain, and North Carolina has the opportunity to promote itself and improve its economy by forging ahead in the blockchain arena.

Beginning in July 2019 the North Carolina Blockchain Initiative convened stakeholders and has served as a central forum for North Carolinians to identify and address issues facing the blockchain ecosystem. For over a year the NCBI worked diligently with the Office of the Lieutenant Governor of North Carolina and is grateful for the support we received from the blockchain community in North Carolina and beyond.

Our task force appointees put in countless hours of work to define and understand the problems North Carolina State Government is trying to solve and develop thoughtful and creative solutions. This report would not have been possible without these efforts and we look forward to continued collaboration.

North Carolina Blockchain Initiative Task Force

The Task Force began by identifying areas where blockchain technology could transform economic growth and rural economic development across North Carolina. The Task Force also researched challenges that the blockchain community may encounter, when doing business in North Carolina. Our research consisted of interviews with stakeholders in local and state government, academia, private industry, and the general North Carolina citizenry. The recommendations provided in this report are intended to best serve the State of North Carolina, its citizens, and its entrepreneurs.

Disclosure

For the avoidance of doubt, this strategic report does not constitute legal advice.

This report is meant to educate and inform the broader North Carolina community about the many opportunities available through the use of blockchain and digital ledger technology. Although we address a myriad of use cases involving blockchain, for the sake of brevity, we do not delve into topics related to data privacy, data security, scalability, costs, and other limitations inherent to emerging technologies. We disclose that we are aware of these limitations and are confident that the blockchain technology community will continue to address these limitations over time.

Recommendations: A Staged Approach Supporting Blockchain Adoption in North Carolina

Recognizing the scope of the industry and public policy that blockchain touches, we recommend a staged approach, set forth below.

Step One: Pragmatic Legislative Considerations

- Informal acknowledgment that the technologically-neutral drafting of the NC Uniform Electronic Transactions Act ("UETA") adequately addresses the legal enforceability of smart contracts, electronic signatures, and electronic recording
- Adopt legislation incorporating blockchain and smart contract taxonomy into state code. Clarifying definitions of blockchain taxonomy and incorporating blockchain taxonomy in state law should help North Carolina become a more attractive jurisdiction in which to engage in blockchain-related business

Step Two: Initiatives to Promote Investment and Innovation

- Create a regulatory sandbox to allow for the use of blockchain and DLT in a controlled environment to develop innovative use cases
- Invest in broadband access infrastructure and technology talent programs in rural North Carolina
- Reinstate North Carolina Qualified Business Venture Tax Credit program and broaden the definition of a Qualified Business Venture, to include blockchain companies
- Adopt other tax policies promoting the adoption of blockchain in industry and innovation:
    - Provide tax credits and write-offs for costs associated with developing blockchain technology
    - Allow taxes to be paid to government agencies in virtual currency
    - Adopt a policy that virtual currency is not property subject to general tax principles applicable to property transactions. This will avoid having each point in a transaction creates a taxable event

Step Three: Regulatory Amendments to Promote Blockchain Innovation in NC

- Exempt digital assets (often called utility tokens or consumptive tokens) from North Carolina's blue sky laws
- Provide that digital assets are personal property and considered intangibles for purposes of UCC Article 9

- Amend North Carolina's Money Transmitter Act. In 2016, the Act was expanded to cover activities related to Bitcoin and other virtual currencies. We suggest adding the following rules or guidelines exempting certain types of virtual currency transactions from regulation:
    - Legislation stating that the exchange of virtual currency for sovereign currency between two parties is not money transmission, but is instead a sale of goods between two parties
    - Legislation stating that the exchange of one virtual currency for another virtual currency, is not money transmission
    - Legislation stating that the transfer of virtual currency by itself, is not money transmission

Step Four: Future Initiatives

- In light of the 2020 COVID-19 Pandemic, state policymakers should ensure that laws and regulations foster the use of blockchain within the healthcare industry
- Incorporate blockchain into state voting systems, allowing for a secure way to vote online. With blockchain, voting data cannot be manipulated and is immediately recorded and validated
- Pilot blockchain for record management, such as UCC filings, recordation of deeds, maintenance of corporate records, in state agencies, such as the DOT, DMV, and DHHS

North Carolina Blockchain Initiative Task Force

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This report would not have been possible without their diligent contributions.

			
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The Office of the Lieutenant Governor

The North Carolina Blockchain Initiative would like to recognize the leadership and support of The Honorable Daniel Forest and his staff in the creation of this task force.

Daniel Forest has served as the 34th Lieutenant Governor of North Carolina since January 2013. Upon winning his first term in 2012, Forest became the first Republican to be elected to that post in over 20 years and the second since 1900. In this position, he also serves as president of the North Carolina State Senate and is a voting member of the State Board of Education, the State Board of Community Colleges, and the State Economic Development Board. He is the chairman of the e-Learning Commission.

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I. Blockchain in North Carolina

In recent years, the promise of blockchain technology has been overhyped, driven in part by the frenzied, exponential growth of the price of bitcoin. In 2020, however, a new trend is taking shape - one which focuses on how technology can pragmatically solve real business issues and add value. Blockchain presents significant opportunities for economic growth and cost efficiencies for businesses, the government, and consumers in North Carolina. The Deloitte 2019 Blockchain Survey revealed that 40% of companies will invest $5+ million in blockchain over the next year and 86% of US companies are already planning to build blockchain teams. In 2019, blockchain companies also raised over $2.8 billion in venture capital deal funding. According to Gartner, blockchain is estimated to deliver $3.1 trillion dollars in value by 2030. The blockchain technology market is expected to grow to over $21 billion (2018-2025 CAGR 38%) while impacting nearly every major industry vertical.

North Carolina has a small, but growing ecosystem built around blockchain technology. In 2014, North Carolina hosted Cryptolina, one of the earliest blockchain-focused conferences in the United States. Charlotte-based Queen City FinTech also operates a 12-week accelerator program to support North Carolina, fintech entrepreneurs. Blockchain legislative activity started in North Carolina in 2016 with the introduction of the North Carolina Money Transmitters Act. Since then, the introduction of new blockchain-focused bills has lost momentum despite widespread adoption in other states, such as Delaware, Arizona, Wyoming, and California.

From an industry standpoint, North Carolina is home to a growing number of companies leveraging blockchain technology. Startups, such as Fluree and Emblem Vault, were respectively launched in 2016 and 2018. In 2018, Chapel Hill-based Morgan Creek Capital Management partnered with Bitwise Asset Management to launch the Digital Asset Index Fund. IBM, located in the Research Triangle Park, is investing heavily in enterprise blockchain solutions, while ConsenSys, one of the world's largest Ethereum developers, has a local office in Raleigh. Red Hat, based in Raleigh, offers blockchain applications and blockchain enterprise solutions (BLOCKAPPS) for both startups and Fortune 500 companies. IBM's Blockchain Platform has been recently optimized to deploy on Red Hat Open Shift platform. Charlotte-based Duke Energy is a member of Energy Web, the world's largest energy blockchain ecosystem for utilities, grid operators, renewable energy developers, and corporate energy buyers. Kaleido, based in Raleigh, is a game-changing blockchain company that delivers blockchain business cloud services that simplify the creation and operation of private blockchain networks.

The following key industries in North Carolina[7] can see significant benefits from the adoption of blockchain technologies.

- Aerospace & Defense
- Agriculture, Food Processing & Manufacturing
- Biotechnology & Pharmaceuticals
- Corporate Headquarters, Businesses & Financial Services

- Energy
- Government Services
- Information Technology
- Supply Chain & Manufacturing (Automotive, Truck, Heavy Machinery, Furniture, Textiles, Plastics & Chemicals)

Rural Economic Development

Blockchain and digital ledger technology also has the potential to improve the rural/urban divide in various ways, including making agricultural supply chains and rural economic development interventions more efficient, transparent, and auditable.
For example, in 2018, Walmart began using blockchain technology to track spinach and lettuce supplies after an E. coli outbreak, allowing Walmart to reduce food waste and quickly identify where the contaminated produce was located in the supply chain. In 2020, a group of students from Eastern Carolina University were finalists in the Pirate Entrepreneurship Challenge for creating a blockchain app that lets consumers access information about food products in grocery stores, including where it was grown and how long it has been sitting on the shelf. Researchers at Appalachian State University are also engaged in public-private collaborations to study and track bee pollinators. Blockchain is also being leveraged in rural communities globally. In China, studies are being conducted on how blockchain can incentive efficient use of energy consumption and maximize the use of agricultural waste.

Across the Midwest USA, the "Agriculture 4.0" movement is taking root in places like West LaFayette, Indiana, where farming communities are leveraging blockchain technology to increase the productivity of farming from the idea stage to end-use delivery in the supply chain lifecycle. The Agriculture 4.0 movement is also leading to the development of "smart rural communities" that harness the power of drones, IoT sensors, and blockchain. To gain further traction, the NCBI Task Force recommends meaningful state investment in rural technology infrastructure, including reliable access to broadband. The CARES Act, for example, has been instrumental in providing hot spots and other types of broadband access to rural communities in North Carolina.

Rural land development may also be favorably impacted by blockchain. Data centers are looking to rural locations in North Carolina due to favorable climate conditions and competitive energy rates. In 2007, Google established a $1.2 billion dollar facility in Caldwell County. Noting that tremendous power usage and environmental impact are factors that disincentivize investment in data centers, the NCBI Task Force recommends that alternative, environmentally-friendly methods of powering data centers also be studied and piloted.

There are many benefits of blockchain to rural communities and include integrated data platforms that build in feedback loops between rural constituents and policymakers, increased tracking and

improvement of the accuracy of broadband adoption, and incentives for the development of technology infrastructure to support sustainability and rural economic development.

North Carolina Legislative Activity

In 2019, North Carolina had no legislative activity related to blockchain. By contrast, 32 states introduced legislation, bills, and resolutions in 2019, many of which have been enacted or adopted.[8] Appendix B highlights the breadth of legislation that has been proposed in other states. There is an immediate need in North Carolina for bipartisan-supported blockchain laws and regulatory policy to encourage economic growth, stimulate digital innovation, and to protect customers and investors.

2016	**North Carolina Money Transmitters Act**
	• Modified regulatory framework for money transmitters operating in the state and established specific regulations for virtual currency transmitters in North Carolina
	• Enabled licensing of virtual currency exchanges by the North Carolina Commissioner of Banks
	• Created a requirement that exchanges would be required to match the value of users' coin investments and hold those coins in reserve (Clarified, 2018)
	• Sponsors
	  ○ Representative Stephen Ross
	  ○ Senator Rick Gunn

2018	**House Bill 86 - Virtual Currency Exchanges: An Act to Make Clarifying Changes to Permissible Investments and Statutory Trust Under the Money Transmitters Act of 2018**
	• Removed the investment matching requirement for virtual currency exchanges in 2016 MTA
	• Sponsors and supporters (including staff)
	  ○ Representative Stephen Ross
	  ○ Senator Jeff Tarte
	  ○ Senator Dan Bishop
	  ○ Senator Rick Gunn
	  ○ Senator Bill Rabon
	  ○ Speaker of the House Tim Moore
	  ○ Representative Jon Hardister

2019	**House Bill 1013: North Carolina Financial and Insurance Regulatory Sandbox** • Sponsor ○ Representative Jason Saine • No vote has been made

Survey of Blockchain Activity in North Carolina Government

The North Carolina Blockchain Initiative Task Force surveyed a number of state government offices, agencies, and commissions to determine whether blockchain technology was being studied or contemplated for use within daily operations. In general, government constituents have not engaged in studies of blockchain but are interested in learning more about the technology and applicable use cases. Some stakeholders that NCBI contacted include:

- North Carolina Department of Insurance
- North Carolina Office of the Commissioner of Banks
- Wake County Register of Deeds Office
- North Carolina Administrative Office of the Courts
- North Carolina Department of Agriculture
- North Carolina Department of Commerce

North Carolina Legislative & Administrative Considerations

The North Carolina Blockchain Initiative has identified several short-term administrative and legislative initiatives and longer-term proposals for further study.

Adopt Regulatory Sandbox

Regulatory sandboxes provide a framework for companies to test new business innovations in a controlled environment under the regulator's supervision. Regulatory sandboxes enable companies to operate at the edge or outside of regulatory frameworks without liability. The purpose of regulatory sandboxes is to provide a way for businesses to innovate quickly in fast-paced sectors of the innovation economy despite the slow pace of regulatory change. A flexible regulatory environment reduces barriers to entry, lowers the cost of innovation, enables regulators to develop novel insights before instituting new regulations and oversight, and facilitates communication between entrepreneurs and regulators.

North Carolina should consider implementing a regulatory sandbox for fintech and innovative companies to develop and test new business models in a safe and supported environment. Creating this regulatory framework would lead to the following benefits:

- More startup firms may incorporate in North Carolina if the numerous compliance and expensive licensing obligations were temporarily modified or eliminated;
- Traditional firms may be more willing to invest in innovative technologies such as blockchain if there were clear regulatory exemptions and support from regulators; and
- Increased dialogue between regulators and innovators would foster entrepreneurship, mitigate risks by informing innovators of how new technologies may contradict existing laws, and equip regulators with the knowledge needed to construct well-defined regulations that protect consumers.

Arizona, Utah, and Wyoming have already adopted regulatory sandboxes, and South Carolina is voting on similar legislation in 2020. Several foreign nations, such as Australia, China, and Singapore, have created regulatory sandboxes, which has encouraged many innovative technology

companies to build and test their products in these foreign jurisdictions. The slow adoption of regulatory change in the United States has caused the nation to miss out on potential opportunities for economic growth.

Acknowledge Legal Enforceability of Smart Contracts, Electronic Signatures, and Electronic Recording

The Uniform Electronic Transactions Act is a federal law that gives legal recognition to electronic signatures, recordkeeping, and contracts. Most states have a version of the UETA, including North Carolina. Several states, such as Arkansas, Arizona, Illinois, Tennessee, have recently amended legislation to ensure that signatures, records, and smart contracts obtained through blockchain technology are legally valid. However, the NCBI Task Force recommends that no amendment be enacted to the state UETA. In alignment with guidance provided by the Uniform Law Commission, (most) state UETA laws already adequately govern the concept of blockchain signatures, records, and contracts in a technology-neutral way that supports the longevity and relevancy of the Act in light of new technological advancements. Additional state legislation, inconsistently drafted, will confuse the marketplace, potentially lead to litigation, and hinder innovation. Alternatively, the NCBI recommends that an informal acknowledgment or guidance be issued to the public which states that North Carolina's UETA sufficiently addresses blockchain-enabled electronic signatures, records, and contracts. With clear guidance, consumers and businesses will better understand the scope of legality in using smart contracts and blockchain signatures.

Tax Policies Promoting Innovation

The NCBI recommends that virtual currency tax obligations are clarified, and that the legislature develop innovative tax policies that take into account how virtual currencies work and are being used. In order to be an effective tool in e-commerce, virtual currencies cannot generate a new tax liability at each transaction point. This is currently the case under federal IRS tax guidance, which treats virtual currency as property. This is inefficient for online and e-commerce applications. It impedes the use of virtual currencies as a payment method. A virtual currency cannot be effectively leveraged in situations where the tax liability must be assessed each time it is used to make a small purchase, such as a cup of coffee or movie ticket. The NCBI also recommends that stablecoin transactions are considered non-taxable events.

Extend Qualified Business Vehicle Tax Credit

North Carolina State Government should encourage additional innovation by extending tax credits and write-offs to qualified businesses. Small businesses across North Carolina should not be burdened with the growing costs related to developing blockchain technology and enhancing it once it is distributed to the general public. These costs should be considered business expense write-offs. Traditional write-off programs may be very beneficial to the creation of these projects or companies that wish to leverage blockchain technology. Additionally, tax credits can be effective at encouraging current businesses to expand their research and development and conduct business in that state.

Allow Taxes and Fees to be Paid to Government Agencies in Virtual Currencies

Such authorization would further promote the use of technology in commercial transactions. This ability has been implemented in Seminole County, Florida, which now accepts bitcoin and bitcoin cash for the payment of property taxes, driver's licenses, and other government services. In November 2018, the State of Ohio launched a payment portal for businesses to pay certain tax obligations through bitcoin.

Adopt Blockchain Taxonomy in North Carolina Legislation

The NCBI Task Force recommends that North Carolina works towards clarifying and adopting blockchain-related definitions and terms in applicable statutes and regulations so that there is regulatory certainty and harmonization with other blockchain-related state and federal laws. Colorado, Missouri, Nevada, and Wyoming have enacted similar measures, such as defining "digital tokens," "consumptive purpose," and "certificate token."

Other states, like New York, have legislation pending that would define "digital ledger technology" and "smart contracts." Illinois has made the most progress in this area through the enactment of the Blockchain Technology Act, which provides for the definitions of blockchain-related taxonomy and outlines permitted uses of blockchain in transactions and proceedings. Clarifying and incorporating blockchain taxonomy in state law will make North Carolina a more attractive jurisdiction in which to engage in blockchain-related business.

Amend Money Transmitter Act to Exempt the Exchange of Cryptocurrency for Sovereign Currency Between Two Parties

Virtual currency businesses are subject to state money transmitter laws and the oversight of federal financial services agencies. The regulatory compliance requirements are a heavy burden for many startups who lack the resources and know-how to navigate money transmission laws. North Carolina currently regulates the transmission of virtual currency under the Money Transmitter Act (MTA). The NC MTA defines "money transmission" as "the act of engaging in the business of receiving money or monetary value for transmission within the United States or to locations abroad by any and all means, including payment instrument, wire, facsimile, or electronic transfer." The NC MTA also defines "monetary value" as "a medium of exchange, whether or not redeemable in money." As a result, virtual currency exchangers that exchange virtual currency for fiat currency or other virtual currencies are regulated under the NC MTA.

In 2019, Texas issued a Supervisory Memorandum 1037, which provides helpful guidance on the regulatory treatment of typical cryptocurrency transactions. Per Memo 1037, virtual currency is not money under the Texas Money Services Act, and virtual currency exchanges do not need a currency exchange license for transactions exchanging virtual currencies with sovereign ones.

The NCBI Task Force recommends that North Carolina issue similar virtual currency-friendly regulatory guidance and adopt legislative amendments to the North Carolina Money Transmitter Act that exempt the following virtual currency transactions:

- Exchange of virtual currency for sovereign currency between two parties is not money transmission but is instead a sale of goods between two parties.
- Exchange of one virtual currency for another virtual currency is not money transmission.
- Transfer of virtual currency by itself is not money transmission.

While the North Carolina Commissioner of Banks has clarified that the NC MTA regulates the transmission of virtual currency, virtual currency miners and individuals who use virtual currencies to buy and sell goods and services are exempt from regulation. Furthermore, smart contracts, colored coins, and smart property are generally exempt from the NC MTA, although more guidance is needed as this area of innovation continues to evolve.

North Carolina "Blue Sky" Securities Laws Should Exempt "Utility" Tokens that are Designed for Consumptive Use

Montana, Wyoming, and Colorado are some of the first states to declare that "utility tokens," as a new asset class, are exempt from securities laws as long as they have a "primarily consumptive" purpose. Typically, "consumptive purpose" is defined as providing or receiving goods, services, or content, or access to goods, services, or content. By contrast, if an issuer markets a token as an investment or for speculation, the securities exemption does not apply. Issuers of utility tokens in these states generally still have to give notice to the securities commissioner and file certain disclosures, however, the immense and costly burden of having to navigate securities registrations and licensing requirements has been eliminated.

The NCBI Task Force recommends that North Carolina adopt legislation similar to the Colorado Digital Token Act and other states which exempt utility tokens that are designed for consumptive use from securities laws and licensing requirements. Such legislation will provide regulatory clarity to startups and companies that would like to raise capital through the issuance of tokens, coins, and virtual currencies. This recommendation does not include creating an exemption for tokens and currencies that are clearly investment contracts or securities, as the NCBI Task Force acknowledges the importance of securities laws in protecting consumers from fraud.

Develop Blockchain Innovation Council

In the interests of maintaining North Carolina's competitive advantage and developing blockchain-based economic development, the NCBI Task Force recommends that North Carolina establish a state board or commission to advance the development of blockchain technology within the state. North Carolina has a long, rich history of establishing boards and commissions to engage industry experts in public service and help make decisions that shape the quality of life in our state. Not only would this office work to determine applications of blockchain that may reduce costs for taxpayers, but this office could also provide a forum for entrepreneurs to best understand the laws

of North Carolina surrounding digital assets, virtual currencies, and blockchain. Further, this Council could be an advocate for blockchain development and work to attract economic development and talent to North Carolina. This Council – which may be housed in the Office of the Governor, Lieutenant Governor, Department of Commerce, Economic Development Partnership of North Carolina, or other government entity whose purpose consists of supporting innovation and growing the economy – may also oversee an interagency task force consisting of agency officials and private industry members to research and develop proposals to implement blockchain solutions within state government.

Encourage Insurance Innovation

The NCBI Task Force recommends that North Carolina promote the use of blockchain in the insurance industry through underwriting, record keeping, customer identification, and claims management. North Carolina should consider enacting policies that promote the study and expansion of blockchain projects to facilitate the technology's adoption. The North Carolina Department of Insurance (NCDOI) and Commissioner of Insurance should confirm that they welcome the use of blockchain technology to improve the insurance industry, enhance the licensing process, and educate consumers. NCDOI regulators should host opportunities to learn from the industry the potential benefits of insurance through blockchain. Early engagement and support from policymakers and regulators for the adoption of blockchain in the insurance industry is essential to enabling adoption in this regulated marketplace.

Pilot Opportunities

Encourage Private Industry to Leverage Blockchain-Enabled Corporate Record Management

The NCBI Task Force recommends that the Office of the North Carolina Secretary of State consider permitting private businesses to maintain corporate records, and memorialize ownership, through the use of blockchain technology. Doing so will provide a gateway for companies to develop innovative new methods of organization, streamline the efficiency of paying out distributions or dividends, and provide shareholders with better means to act on their rights within a corporation. Traditional corporate processes can be onerous on the overall operations of a business. By eliminating the requirement for these processes, businesses and corporations can focus on growth and devote their time to economic activity.

Implement Blockchain-Based Pilot Programs to Digitize Records, Attestations, Identity, and Storage

Lawmakers and state regulators should consider applying blockchain technology as a solution to the provision of identity services. The Federal and State government play a principal role in the establishment of identity through driver's licenses, birth certificates, social security numbers, passports, etc., in the form of plastic ID cards, paper certificates, and digital records. One of blockchain's most impactful and innovative use cases is directly tied to the establishment of digital identity. At the state level, North Carolina lawmakers and agencies should begin exploring, and potentially piloting, blockchain-based identification systems to issue verifiable credentials that can be used universally.

Lawmakers and agencies should focus on interoperable solutions that leverage independently verifiable attestations and comply with identity standards like Verifiable Credentials and Decentralized IDs (DIDs) (both standard candidates as part of the World Wide Web Consortium, also known as W3C). This program can occur within the North Carolina Division of Motor Vehicles, for example. These systems can streamline government services and reduce the costs to taxpayers.

Incorporate Blockchain-based Voting Systems in North Carolina Elections To Provide a Secure Way to Vote Online

The NCBI Task Force recommends that North Carolina incorporate blockchain-based voting systems in local and state elections. To date, West Virginia, Colorado, Oregon, and Utah have successfully piloted blockchain-based voting systems. In 2020, the United States Postal Service filed a patent for a blockchain voting system.

Voting in North Carolina is ripe for reform. In recent years, North Carolina elections have made news headlines for various reasons, including election fraud. Using blockchain-based voting systems would provide a secure way for North Carolina citizens to vote online. Because blockchain-based systems are digital ledgers, votes can be easily recorded and counted online while remaining tamper-proof. Digital identity solutions can also be integrated into blockchain

platforms to verify the identity of voters. Blockchain-based voting systems would also benefit two major subsets of the North Carolina population: (1) military and overseas voters, which make up the third-largest military population in the United States; and (2) disabled citizens who face mobility issues that prevent them from civic engagement. A blockchain-based voting system would allow citizens at home and abroad to vote in elections without having to deal with various challenges, including the unreliability and untimeliness of the postal service, both nationally and internationally.

Pilot Blockchain Initiatives in Higher Education

Blockchain can transform higher education due to the technology's ability to securely store tamper-proof records, including degrees, certificates, and diplomas. According to a Gartner survey, 2% of higher education respondents are already deploying blockchain credential processes and 18% are planning to do so in the next two years. The University of Melbourne, Australia, is currently using the blockchain so that students can share their credentials with employers and so that the university can preserve records for students. By giving students control over their credentials, the need for third-party verifiers is removed. Creating a learning credential ecosystem will also prevent resume fraud. An educational consortium is currently using the IBM Blockchain to create a digital credential system on the blockchain to identify pathways for advancement for job applicants. The US Department of Education's Office of Educational Technology has convened an Education Blockchain Action Network to discuss how blockchain can improve policies and practices in higher education.

The NCBI Task Force recommends that North Carolina establish an open standards-compliant blockchain credentialing ecosystem for North Carolina community colleges and the UNC System. Central New Mexico community college is an early adopter of the learning credential blockchain space. In addition to a credentialing system, North Carolina should consider establishing a system for blockchain-anchored immunization records that securely store and instantly verify records for schools and employees.

The NCBI Task Force also recommends that North Carolina support and fund educational blockchain initiatives and curriculum development within the UNC System and NC community colleges, especially in rural communities and underserved regions of the state. Investing in education and bringing talent programs, such as Code Academy, to rural North Carolina, will create talent pipelines that will support regional and rural economic development. Likewise, the NCBI Task Force recommends that North Carolina support public-private partnerships to support the development of use cases in higher education.

Study, Pilot, and Evaluation Blockchain Technology in Healthcare

In light of the 2020 COVID-19 pandemic, the NCBI Task Force recommends that North Carolina foster an environment for companies, academia, and entrepreneurs to study, pilot, and evaluate the use of blockchain in the healthcare industry. The NCBI Task Force also encourages policymakers to enact laws and regulations that do not inhibit the adoption of blockchain in healthcare.

Entrepreneurs are already inventing novel ways to combat the COVID-19 pandemic with practical blockchain use cases. Brooklyn, New York startup, Kadena, has created an app that lets users track COVID-19 test kits to ensure that kits aren't being swapped out for fraudulent ones. Market suppliers of PPE (Personal Protective Equipment) have had to leverage existing blockchain-enabled systems to connect non-traditional medical suppliers and health organizations to trusted sources of supplies. The Rapid Supplier Connect system, built by Chainyard's Trust Your Supplier and IBM, is a platform designed to address supply chain shortages for critical supplies.

Blockchain use cases can also improve and secure prescription drug tracking, improve pharmaceutical supply chains, protect pharmaceutical product integrity, and transform health care systems by creating shared data networks with nationwide interoperability. The US Office of the Coordinator for Health Information Technology has already solicited research on use cases that impact electronic health record management. The FDA has also piloted a pharmaceutical tracing system.

With North Carolina serving as home to several biotech and pharmaceutical companies, including Bayer, LabCorp, Merck, and Biogen, the NCBI Task Force recommends support for blockchain development, innovation grant programs, and blockchain-related public-private partnerships in the healthcare industry.

Consider Blockchain for Bond Issuance

The NCBI Task Force recommends that North Carolina consider issuing future bonds and debt securities using blockchain. Among the many benefits of blockchain technology is the ability to reduce the number of intermediaries involved in a transaction. Municipal bonds that are issued on a blockchain would require fewer intermediaries to participate in the transaction, and thus lead to lower transaction costs. As learned during a fact-finding mission to Washington, DC, the NCBI Task Force learned that the World Bank launched a bond using blockchain technology. At the municipal level, the city of Berkeley, California has created a blockchain-based bond to publicly finance community projects. The project includes "micro-bond" offerings, allowing bonds to be issued in the range of $10 to $25.

II. Appendices

Appendix A: Industry Use Cases

Aerospace & Defense

Deloitte recently completed a study on blockchain and the future of aerospace and defense. Their findings indicate "Blockchain massively reduces the burden of paper leading to digital traceability". Additionally, they find implementing blockchain solutions solves a number of significant issues currently experienced in the industry today.

"The A&D industry is constantly under the burden of creating, processing, managing, and storing paper records. Much of this is to satisfy regulatory compliance and is a key contributor to aviation safety and IP protection, but much of it is a relentless and constant duplication of documents as they move across organizational boundaries. Furthermore, companies store years of part records in warehouses, third-party locations, and even newly acquired shipping containers as the sheer volume of paperwork overwhelm the organization."

A further use case for North Carolina can be found in Appendix B.

Agriculture and Food Traceability

IBM, Walmart, and many other major private and public institutions are developing systems to leverage blockchain across the supply chains. The IBM Food Trust Initiative has grown into a global consortium that includes big-name companies such as Dole, Driscoll's, Kroger, Nestle, Tyson, and Unilever. Frank Yiannas, formerly the Vice President for Food Safety at Walmart, helped lead the initiative and has since gone on to become the Deputy Commissioner for Food Policy and Response at the FDA. Walmart has said that the improved data traceability provided by the IBM platform reduced the time it took to trace a mango from the store back to its source from seven days to 2.2 seconds. This demonstration shows how blockchain can significantly reduce the time to recall affected products in a contaminated food supply chain.

A further use case for North Carolina can be found in Appendix B.

Biotechnology & Pharmaceuticals

Blockchain represents a significant opportunity in advancing transparency, tracking, and verification amongst the global biotech and pharmaceutical markets. As an example, in 2013, Congress enacted The Drug Quality and Security Act (DQSA) from which Title II "outlines steps to build an electronic, interoperable system to identify and trace certain prescription drugs as they are distributed in the United States." Blockchain, as shown by a peer-reviewed study done by UCLA, The Last Mile: DSCSA Solution Through Blockchain Technology: Drug Tracking, Tracing, and Verification at the Last Mile of the Pharmaceutical Supply Chain with BRUINchain, demonstrates the solution to fully meet the obligations as set forth by the act.

Financial Services

Blockchain has been a natural fit for financial services since day one. Naturally, of course, as Bitcoin helped give rise to the technology. Blockchain has played a role in trade settlements, remittances, international finance, and many more areas.

As an example, MoneyGram International Inc., partnered with blockchain-based remittance company Ripple to help it disrupt the global money transfer space. Alex Holmes, MoneyGram Chairman, and CEO, says that the xRapid solution from Ripple could "dramatically streamline [MoneyGram's] global liquidity management."

Healthcare

Blockchain holds the promise to transform healthcare. One example of that is through leveraging inherent properties of the technology creating an interoperable data exchange. Deloitte explored this opportunity and issued a white paper saying, "The blockchain transaction layer could enable access to a rich set of standardized, non-patient identifiable information". Additionally, they conclude "A blockchain solution could address the HIPAA Privacy Rule by separating and encrypting identity, PII, and PHI."

At the time of this report, there are a number of companies in North Carolina working on advancing blockchain in healthcare. One such example spearheaded by Unboxed Venture Studio, saw Emblem Vault and Trilliott combining blockchain and the Internet of Things (IoT) to develop a COVID-19 response solution for rapid deployment of medical set-ups, such as field hospitals. Leveraging blockchain will help reduce the cost of disaster response from an inefficient understanding of real-time supply chain status for equipment and medical supplies and loss of equipment recovery post-event.

Cybersecurity

Blockchain offers many of the attributes to strengthen general cybersecurity risk factors. Although there are many areas that could be highlighted, this article by Infosecurity Magazine demonstrates some key areas blockchain plays a role in a more secure digital world. Additionally, Infosys points out areas where blockchain technologies enable a new standard for security. Some highlights from the article:

- Data protection and privacy. The technology provides selective access to transactions and information in the distributed ledger with minimal governance. Also, blockchain doesn't give cyberattackers traditional data protection targets and the ability to undercut privacy challenges. Overall, that makes it harder to access or modify information in blockchain ecosystems.
- Smart contract security. Blockchain components like smart contracts, applications, APIs, digital assets, and wallets must be tested for access control, authentication, data security, and business logic validation. This provides greater confidence among participants in the permissioned chains.
- Public key infrastructure management. Asymmetric cryptographic keys and digital signatures are core aspects of blockchain security. In its implementation, the public key defines the digital identity to node participants. However, the private key authorizes the actions, including securely encrypting, signing, and verifying transactions. Asymmetric cryptography in blockchain provides benefits similar to those of traditional encrypted transactions.

Appendix B: Blockchain Legislation Across the United States

Legislative Activity in Other States at Time of Publication

Arkansas

- HB 1944 defines blockchain and smart contract-related terms (2019)
- Electronic signatures obtained through blockchain are valid electronic records (state version of UETA) (2019)
- Effectiveness of smart contracts (2019)

Arizona

- Electronic signatures obtained through blockchain are valid electronic records (state version of UETA) (2017)
- Effectiveness of smart contracts (2017)
- Retainment of ownership rights (2017)
- Expand the definition of "written" or "writing" with respect to blockchain and electronic records (2018)
- Cities and towns are prohibited from regulating the "running of nodes" as a means to validate and encrypt transactions on the blockchain
- No person shall be required to use or be subject to electronic firearm tracking technology, including blockchain-based tracking systems.

California

- Articles of Incorporation for corporations and social purpose corporations may include a provision authorizing record-keeping to be recorded and maintained on the blockchain
- Definition of "blockchain" added to California Government Code (2018)
- Government Operations Agency must appoint a blockchain working group to report on risks and benefits of blockchain by the state government and California businesses (2018)
- SB 373 would authorize a county to issue certified copies of birth, death, and marriage records on the blockchain, thereby exempting these records from the legal requirements intended for traditional physical records (**pending** 2019)

Colorado

- Office of Information Technology is required to evaluate the potential use of blockchain and DLT for any new tech project
- Higher Education Institutions are encouraged to use and teach about blockchain and DLT in curricula
- Department of State should consider the use of blockchain or DLT to protect data
- Department of Regulatory Agencies should consider secure encryption methods
- Office of the Chief Information Security Officer should assess data systems of each public agency for potential adoption of blockchain or DLT
- SB 23 exempts certain digital tokens from securities laws if they are used for consumptive purposes
- "Digital Token" and "consumptive purpose" defined in 2019, similar to Wyoming
- SB 184 proposed a study of blockchain for a database of water rights and water banks (Failed, 2019)
- HB 1247 directs the Secretary of Agriculture to study blockchain for agricultural purposes

Delaware

- Business entities authorized to use DLT for certain communications and for the storage of records (2017)

Illinois

- Blockchain Business Development Act enacted to provide for the creation and regulation of blockchain-based limited liability companies and to study blockchain use in public agencies (2019)
- Blockchain Technology Act enacted to define blockchain and related terms, to provide for the effectiveness of smart contracts, records, and signatures maintained using blockchain technology, and to provide limitations on the use of DLT (2019)

New Jersey

- AB 3613 and SB 2462 introduced to allow corporations to use electronic networks, including databases that use blockchain technology to satisfy recordkeeping requirements (2019)
- SB 2297 established NJ Blockchain Initiative Task Force (2019)

New York

- AB 1683 and SB 4142 would add definitions of "blockchain" and "smart contracts" to law and provide for the effectiveness of signatures and records obtained through blockchain technology (2019)
- AB 1398 and SB 6037 would add "distributed ledger technology" to economic development law for businesses dealing with certain financial services and software development (2019)
- AB 2239 and SB 5060 would establish the Office of Financial Resilience, which will build blockchain-based solutions and advocate for blockchain startups

South Carolina

- HB 4351 and SB 738 were introduced to enact the South Carolina Blockchain Industry Empowerment Act to allow share certificates to be represented in the form of certificate tokens, to provide that a developer or seller of an open blockchain token is not an issue of securities, to develop a fintech sandbox, and to provide definitions and regulations of digital assets (Pending, 2020)

Vermont

- Addressed the authentication, admissibility, and presumptions regarding digital records stored in a blockchain under rules of evidence (2015)
- Businesses may elect to create a blockchain-based limited liability corporation (BBLLC) for the purpose of operating a business that uses blockchain for a material portion of business activities (2017)

Wyoming

- Wyoming Money Transmitters Act exempts a person who develops, sells, or facilitates the exchange of an open blockchain token
- Developers and sellers of an open blockchain token are exempted from certain securities laws if certain requirements are met
- Wyoming Utility Token Act enacted to provide that certain open blockchain tokens do not constitute securities because they can only be used to obtain a fixed amount of services, content or property, and are classified as intangible personal property (2019)
- HB 70 allows the secretary of state to implement a blockchain-based filing system through which all commercial records may be submitted (2019)
- HB 185 authorizes corporations to issue stock or shares in the form of certificate tokens that are entered into secure technology or blockchain system (2019)
- SB 125 provides that digital assets are personal property and shall be considered general intangibles for purposes of UCC Article 9, and provides that digital securities are investment property for purposes of UCC Article 8 and 9, and clarifies that virtual currency is intangible personal property and is considered "money" only for the purposes of UCC Article 9 (2019)

- HB 74 allows the creation of a special depository institution as a corporation for the purposes of serving the special needs of blockchain innovators (2019)
- Statutory Amendments to Digital Assets were passed (2020) that:
    - modify the means to perfect a security interest in virtual currency and digital securities;
    - modify provisions related to security agreements involving virtual currency and digital securities;
    - amend duties and requirements for banks that provide custodial services;
    - clarify the application of digital asset statutes, the duty of digital asset custodians to pay supervisory fees, and the jurisdiction of Wyoming courts to hear cases related to digital assets; and
    - provide for an effective date.

State Blockchain Task Forces

California: 2018 Working Group
Colorado: 2018 Blockchain Council
Connecticut: 2018 Working Group
Delaware: 2016 Blockchain Initiative
Florida: 2019 Task Force
Illinois: 2016 Task Force
Kentucky: 2020 Task Force
New Jersey: 2019 Task Force
New York: 2017 Task Force
North Carolina: 2019 Task Force
North Dakota: 2019 Legislative Management Study
Wyoming: 2018 Task Force

State Initiatives

Blockchain in State Government Legislation	Arizona, California, Hawaii, Maine, Maryland, Nebraska, Nevada, New Jersey, New York, Tennessee, Vermont, Virginia, and Wyoming
Blockchain Voting in Elections	Utah, West Virginia, Colorado, Washington
Blockchain Digital Identity	Illinois

Blockchain Real Estate Transactions	Vermont

State Regulatory Sandboxes

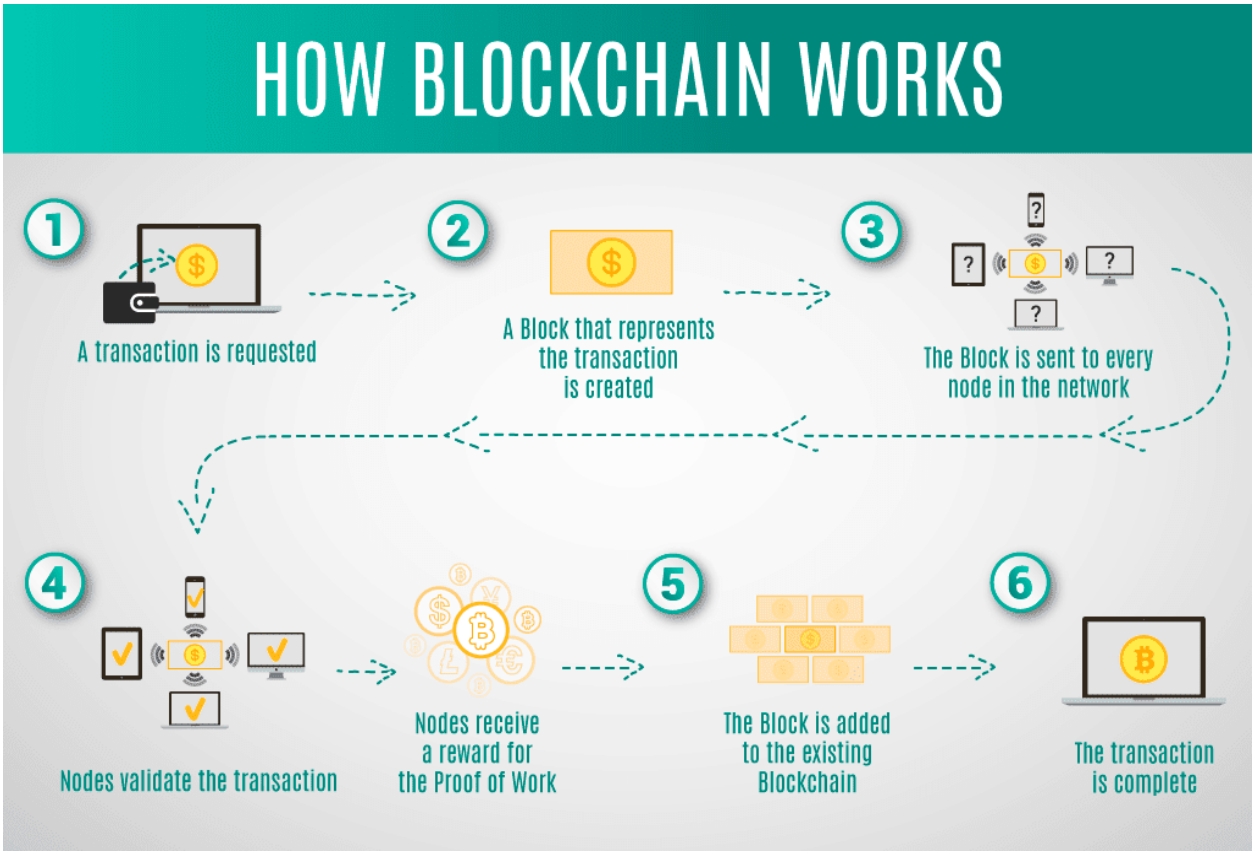
Arizona	2018 Fintech Sandbox
Florida	2020 Financial Technology Sandbox
Utah	2019 Regulatory Sandbox
Wyoming	2019 Financial Technology Sandbox
South Carolina	Financial Technology Sandbox Act (pending 2020)

Appendix C: Blockchain Explained

What is Blockchain?

In simple terms, a blockchain is a database, that uses a distributed ledger that is shared across a network of computers. Each block in a blockchain contains a collection of data or transactions. Every time a new transaction occurs on the blockchain, a record of that transaction is "chained" or added to every participant's ledger on the network. This architecture is known as "Distributed Ledger Technology." Data blocks on the blockchain are added in chronological order by a cryptographic hash function, which is later used to verify the authenticity of a piece of data. In order to ensure accurate record-keeping, the entry of new data must be authenticated by every participant in the network, a process known as a "consensus mechanism." Blockchain is the underlying architecture that powers Bitcoin, a public ledger system used to protect against the double-spending of digital currencies and modification of previous transaction records.

Figure 1: How Blockchain Works 5,6



Core Components of a Blockchain:

- **Transaction:** any type of data (records, financial information, etc.) that is stored within a block
- **Block:** a data structure which stores transactions, and which can be distributed to all nodes in a network
- **Chain:** a sequence of blocks permanently secured in chronological order
- **Nodes**: user or computer within the blockchain that has an independent copy of the entire blockchain ledger
- **Distributed Ledger**: the interconnected network of computers or nodes that each have an independent copy of the entire blockchain ledger, consisting of chains, blocks, and transactions
- **Consensus Protocol**: the governing rules that carry out blockchain operations, typically conducted in a way where all nodes agree that data is verified
- **Miners**: specific nodes which perform the block verification process before adding new blocks of transaction data to the blockchain ledger

A Brief History of Blockchain

In 1991, a team of researchers developed a tool to timestamp digital documents so that they could not be tampered with or backdated. In 2008, Satoshi Nakamoto, an anonymous figure credited with developing Bitcoin, applied this concept to the design of a public ledger for all financial transactions on a network. The reason for developing the concept was to create a system for electronic transactions, including the transfer of digital money, without relying on trust. Each transaction could be digitally time-stamped without a trusted party through the use of an encrypted hash function. In 2009, Satoshi Nakamoto published the distributed ledger specification to the open-source community and left the project running. Because the protocol and software are published openly, anyone can review or make modifications to the source code. Two of the largest public blockchains born out of Satoshi Nakamoto's academic paper include Bitcoin and Ethereum. Unlike Bitcoin, Ethereum can record on its network other assets, such as contracts, not just currency.

Why Blockchain Matters

Blockchain obviates the need for a central authority to verify trust and the transfer of value. It transfers power and control from large entities to the many, enabling safe, fast, cheaper transactions despite the fact that we may not know the entities we are dealing with.

The mechanics of the Blockchain are novel and highly disruptive. As people transact in a Blockchain ecosystem, a public record of all transactions is automatically created. Computers verify each transaction with sophisticated algorithms to confirm the transfer of value and create a historical ledger of all activity. The computers that form the network that are processing the transactions are located throughout the world and importantly are not owned or controlled by any single entity. The process is real-time and much more secure than relying on a central authority to verify a transaction.

Key Takeaways:

- Blockchain is a distributed ledger, or more simply, a ledger of stored transactions.
- Blockchain allows transactions to be completed without an intermediary.
- Transaction records are permanent and can be audited easily.

Essential Characteristics of Blockchain Technology:

- Transparent
- Auditable
- Cryptographically Secure
- Immutable

A Taxonomy on Digital Forms of Money and Assets

Cryptocurrency

A cryptocurrency is a digital or virtual currency that is secured by cryptography. A defining feature of cryptocurrencies is that they are generally not issued by any central authority, rendering them theoretically immune to government interference or manipulation.
Although there is currently no true standard for defining cryptocurrencies, they can generally be viewed in two ways: Coins and Tokens.

- Coin - Coins (or digital coin or crypto coin) may be viewed as a cryptocurrency with their own blockchain. Bitcoin is the most common example. Another example is "Ether" which operates on the Ethereum blockchain. They are generally used similar to money - to transfer, store value, or use as a unit of accounting.
- Token - Tokens are a cryptocurrency that is created on an existing blockchain. Tokens are generally used within a decentralized application (dApp) or as a digital representation of a physical thing. In a dApp, a token may be used as a credit to play a game or access certain features.

As a digital representation of a physical asset, a token can be used to purchase a fractionalized portion of a real estate contract. The concept, called tokenization, is one of the largest segments of economic growth in this emerging technology. The financial value of tokens is determined by their current market value which in turn depends on the level of user's trust in a project. There are generally two types of tokens outlined below.

Utility Token

These tokens should provide a true utility or access point to a product or service offered by a company. Utility tokens are not created to be an investment

Security Token

A security token is a tokenized digital security that can be sold in cryptocurrency exchanges. They can be used to trade real financial assets such as fixed income, equities, and use a blockchain to store and validate token transactions. In the United States, security tokens are subject to the SEC under the same laws as traditional securities

Token Issuance

The first platform used for the issuance of user tokens was the Ethereum platform. It is a decentralized virtual machine whose transaction is based on smart contracts using the Proof-of-work (PoW) method. There are typically two types of token issuances outlined below.

- Security Token Offering (STO) - Issued security tokens are actual securities, like stocks or bonds, tied to a real company. In this sense, STOs are actually more similar to Initial Public Offerings (IPOs), with the difference being that one isn't required to be an accredited investor to take part in the initial offering. The issuance of security tokens should be associated with official registration and execution of all U. S. Regulatory requirements for safe and legal cooperation with American investors in the area of blockchain technologies. Generally, legislation understands that if a passive financial return is expected from the investment, then it is classified as a security
- Initial Coin Offering (ICO) – Although the first ICO was launched in 2013 by Mastercoin, the craze hit a peak in 2017 when a number of blockchain/cryptocurrency-based start-ups launched ICO's raising millions, if not

billions, of dollars in capital. Different from an IPO though, an ICO does not give the investor an ownership stake in the company, but pre-mined (and generally worthless) cryptocurrency in the hopes the company's performance will significantly increase its value. This wave helped bring blockchain and cryptocurrencies to mainstream attention

Virtual Currency

Virtual currencies are a type of digital currency, typically controlled by its creators and used and accepted among the members of a specific virtual community.

Stablecoin

A stablecoin is a type of cryptocurrency that is designed to maintain a stable market price. They generally fall into two variants: Collateralized and Non-Collateralized.

- Collateralized
    - Fiat-Backed - Based on the value of the backing currency, which is held by a third-party regulated financial entity, and can generally be redeemable from the issuer and traded on an exchange
    - Crypto-Backed - are backed by cryptocurrency but use protocols to ensure that the value doesn't fluctuate with the price of the token backing the stablecoin
    - Asset-Backed - Is underpinned by reserves of assets other than fiat or cryptocurrencies
- Non-collateralized - Supply is performed by an algorithm or a decentralized model of governance based on holder votes. Also referred to as 'algorithmic stablecoins', these coins do not have any underlying asset

Central Bank Digital Currency (CBDC)

Central bank digital currency is the digital form of fiat money. Central bank digital currency is different from virtual currency and cryptocurrency, which are not issued by the state and lack the legal tender status declared by the government.

Synthetic Central Bank Digital Currency (sCBDC)

According to the International Monetary Fund, in the sCBDC model, which is a public-private partnership, central banks would focus on their core function: providing trust and efficiency. The private sector, as providers of stablecoins, would be left to satisfy the remaining steps under appropriate supervision and oversight, and to do what they do best: innovate and interact with customers. (Reference)

Digital Asset

The term "digital asset" can be broadly defined as anything that exists in binary data which is self-contained, uniquely identifiable, and has a value or ability to use. In reference to blockchain technology specifically, though, the definition is typically more limited. The SEC has defined a "digital asset" as an asset that is issued and transferred using distributed ledger or blockchain technology, including, but not limited to, so-called "virtual currencies," "coins," and "tokens."

Digital Object

A digital object is 'an object composed of a set of bit sequences' (CCSDS, 2012). Digital objects are an abstraction that can refer to any type of information. The object may be simple or complex, ranging from values used in databases to graphics and sounds.

Owning Cryptocurrencies

There are a number of ways from which one can own one of the many cryptocurrencies. First, in order to own any cryptocurrency, there should be a basic understanding of how ownership works.

Public and Private Keys

Bitcoin, as with most cryptocurrencies, uses asymmetric, otherwise known as public, key cryptography. Simply, there are two keys, which are basically very large numbers, that are paired together but not identical (asymmetric). One key is called the public key (used as your cryptocurrency "address") and can be shared. The other is the private key and is only known by the owner.

Wallets

Cryptocurrency wallets are used to store your keys while also acting as the interface with blockchains in order to manage or use your cryptocurrencies. Each cryptocurrency will have its own set of keys in your wallet. To receive or send a cryptocurrency, you will use that cryptocurrency address or public key. Cryptocurrency private keys can be "backed up" by a Mnemonic Phrase - a random list of 12 or 24 words that are used to recover your cryptocurrency if anything were to happen to your wallet.

Types of wallets: There are a number of different terms and implementations used for wallets. For this paper, we will focus on the two key implementations.

- Hosted Wallets (Hot/Hosted/Custodial) - Your keys are stored by a third party. This is most common with exchanges, such as Coinbase
- Unhosted (Cold Storage/Non-Custodial) - You store your own keys. These can be using a browser plugin, a USB drive type device, or even printed on paper

Key Takeaways:

- Cryptocurrencies are cryptographically secured, digital stores of value
- Cryptocurrencies generally are referred to as either digital coins or tokens, each with their own use cases
- Digital coins are more similar to traditional money
- Digital tokens either provide value within a network or application or are digital representations of physical things

Consensus Mechanisms

The method in which computers (referred to as "nodes" on a blockchain network) come to an agreement on the validity of changes to the blockchain is known as the consensus mechanism. Consensus mechanisms ensure all nodes are in sync and agree on legitimate transactions.

The consensus mechanism outlines the rules in which nodes can work to "**mine**" transactions and receive mining rewards. The mining rewards provide incentives for participants in a blockchain network to maintain the consistency and integrity of that network, thereby eliminating the need for any one participant to trust any of the others. It is important to note that some consensus mechanisms, such as those used in permissioned blockchains, are not incentive-based.

Proof-of-Work (PoW)

Proof-of-Work (POW) was the first blockchain consensus mechanism and used by Bitcoin. Many cryptocurrencies use the PoW consensus mechanism.

Proof-of-Work uses a process known as "mining" to validate transactions. Miners, the nodes on the network, solve complex mathematical puzzles that require a lot of computational power. The first one to solve the puzzle gets to create a block and receives a reward for creating a block.

- Nodes compete to "mine" virtual currency by solving complex mathematical puzzles
- After one node solves the puzzle, other nodes on the network confirm whether the puzzle has been solved and the record of this transaction results in a new block being added to the blockchain.
- Bitcoin uses the Proof-of-Work consensus mechanism
- Proof-of-Work is slow and has high energy demands

Proof-of-Stake (PoS)

Proof-of-Stake uses a randomized process to determine who gets to produce the next block. A core component of PoS is based on the theory the participants, those who own tokens, have a vested interest in the maintenance of the network as a strong network can increase the value of the token. Users can stake their tokens to produce blocks and become eligible to produce blocks.

- Proof-of-stake limits the number of computers working on each block, solving the energy consumption problems posed by proof-of-work
- Proof-of-Stake provides the opportunity to solve a block based on the number of digital tokens a user has staked and, potentially, a few other factors like how long they have been stakes
- Randomly selecting "staked" users to provide the next valid block ensures they have incentives to maintain the network to preserve the value of their holdings
- Additionally, in some proof-of-stake models, the user has to lock a portion of their coins or tokens to the network in order to be eligible to provide the block's solution. After this user has proposed a block, other users on the network are given the opportunity to validate the solution. If the validating users determine that the solution is invalid, the proposing user may lose some of the digital tokens they have staked, giving even greater incentives for participants to properly follow the rules for adding new blocks
- Ethereum has a planned update to Proof-of-Stake from Proof-of-Work in 2020

Other Consensus Mechanisms

- Delegated Proof Of Stake (DPOS) - In a Delegated Proof Of Stake system users uses staking of their tokens to vote for delegates. A delegate, in this network, is a person or organization that wants to create a new block. In order to receive votes, they are incentivized to show their value to the community
- Proof-of-Capacity (PoC) – Similar to Proof-of-Work, PoC miners try to guess the correct solution but the solution is pre-stored on a device. The miner uses their extra storage space to store the solution instead of computing power or staking of tokens – the more space you have, the more solutions you can store and the better chance you have of matching, or guessing, the correct solution to mine the next block and earn rewards
- Proof-of-Elapsed-Time (POET) – More commonly used in permissioned systems, POET aims to create a fairer system but ensuring all nodes have an equal chance to win. Nodes win by being the first to complete the designated wait time which is generated at random to all the nodes in the network. It requires each note to be identified, which is why it is common in permissioned systems.

Key Takeways

- Consensus mechanisms are crucial for a blockchain in order to function correctly.
- Consensus mechanisms determine the "rules" in which decentralized, blockchain-based networks validate transactions and reward the validating nodes.
- The two most common mechanisms are Proof-of-Work and Proof-of-Stake.
- There are several consensus mechanisms and likely to be many more in the future.

Smart Contracts

A smart contract is a computer protocol intended to digitally facilitate, verify, or enforce the negotiation or performance of a contract. Smart contracts allow the performance of credible transactions without third parties. These transactions are trackable and irreversible. Smart Contracts have three key properties. They are:

- Self-verifiable
- Self-executable
- Tamper Proof

In 2018, a US Senate report said: "While smart contracts might sound new, the concept is rooted in basic contract law. Usually, the judicial system adjudicates contractual disputes and enforces terms, but it is also common to have another arbitration method, especially for international transactions. With smart contracts, a program enforces the contract built into the code."

Use-Cases

Smart Contracts, with today's blockchain-based implementation, are used for more than just the common contract.

- Internet of Things (IoT)
  With a combination of Blockchain and IoT sensors, product management can be simple and fast through the delivery pipeline. The sensors involved in the system create their own nodes on blockchain and with the help of smart contracts, the location and possession of the respective product can be traced. A smart contract keeps the location status updated through delivery. This helps in ensuring the correctness of the product from the initial shipment to delivery.
- Loans
  With the complexity and regulatory considerations of the mortgage process, smart contracts can be used to ensure accuracy, auditability, and efficiency. The traditional process sees a number of middlemen and third parties trying to coordinate and pass information back and forth. Using smart contracts in this situation is beneficial for many reasons, allowing for a much faster process, clearer coordination between necessary parties, and elimination of unnecessary middlemen making it require fewer resources.
- Supply Chain
  Smart contracts bring transparency to the overall supply chain system. Smart contracts have certain advantages for many industry sectors such as, reducing overhead costs, providing transparency, and saving time. While they are more reliable, secure, efficient, and trustworthy as compared to paper contracts, care needs to be taken to avoid the risks of code corruption and as businesses move forward and accept digital processes, risk awareness is integral too.

Key Takeaways

- Smart Contracts are self-verifiable, self-executable, and tamper-proof rules built into computer code that facilitates, verifies, or enforces the negotiation or performance of a contract without a third party.
- There are many use cases for smart contracts beyond traditional contracts such as verifying steps along a supply chain.
- Smart contracts are generally accepted as a contractual relationship once two parties are engaged in a smart contract-based negotiation or relationship.

Appendix D: Blockchain in North Carolina Stories

Blockchain use cases are best understood in the context of a narrative or personal interaction with the technology. The following use cases, which operate in the domains of aerospace and agriculture, illustrate the pragmatic advantages of blockchain technology. The NCBI Task Force would like to thank the authors for their contributions to this report.

How Blockchain Improves Aerospace Product Design & Manufacturing

By Kirsten Evans, Transportation Impact

Overview

Transportation Impact is a company based in Emerald Isle, North Carolina that maximizes technology, like blockchain, to find value in the logistics supply chain This use case will leverage blockchain technology and all its benefits to see a product in the aerospace industry built from the beginning to end. It will include the product life cycle, the transportation of the product, and the use of various components in the final product.

Manufacturers involved:

- GE Aviation, Asheville, NC – providing engine, avionics, electrical power & the mechanical system for the aircraft.
- Comm Scope Inc, Hickory, NC – providing the radio, television, and communications equipment.
- Belcan, Greensboro, NC – providing seat assembly
- Collins Aerospace, Wilson, NC – repairs station and aftermarket services
- Honda Aircraft Company, Greensboro, NC – providing the wing assembly, airframe structure. HAC will be the location for the final assembly of the aircraft.

Using a hybrid cloud architecture to deploy the blockchain, each company involved or providing any sort of component will join a permissioned blockchain. The protocol for the blockchain will be as follows:

- Each company has “read and write” permissions
- The only transactions that must be validated are transactions for transportation
- To validate these transactions Honda Aircraft must vote to approve
- The transactions added to the blockchain that are building components do not need to be validated or voted on by the rest of the companies. Instead, all of this is managed by the initial smart contract

The first block in the blockchain will just be used for record-keeping. This first block will be the “kick-off” of the project, and it will contain the details of the project in a smart contract. The record will be of the final product description, the roles of each company and potential future companies, and the target date for completion. In order to achieve that target date, the smart contract will consist of the timing for each component or part. The timing will include the start and end dates for each.

The assembly of the airframe begins at Honda Aircraft. Each time a new component is used or added to the structure (even something as small as a bolt), there will be a new block added to the blockchain. Each individual bolt will have its own unique identifier in the blockchain. For this example, we will give one bolt the following ID: 5462376assk.

While the airframe is being manufactured by Honda Aircraft, the engine is being built by GE Aviation and the communications equipment is being developed by Comm Scope. For all three of these companies to know what kind of

equipment they need to be building the blockchain can house high-resolution photos that include dimensions. The benefit here is that Comm Scope does not have to wait for the airframe to be complete before it can start building the lights, radios, tv, etc. As a result, the final product is completed in a more efficient manner.

While these three companies are working, the blockchain is building upon itself with each transaction. The transactions in the blockchain are made up of the component or part ID, the company, the location, the time stamp, and any additional information deemed necessary, such as a certificate of authenticity. As the completion of the product nears, Belcan is notified via a smart contract that it Is time to begin the seat assembly, so that the seat can arrive at the appropriate time for the final product.

The transportation to Greensboro, NC of all the various parts that will make up the aircraft will need to be validated by Honda Aircraft per the permissions of the blockchain. The reason for this is to consolidate when possible and to reduce costs for the project. The transportation carriers can be added to the blockchain with read/write permissions. Adding the transportation carriers to the blockchain increases efficiency. For example, if the carriers are transporting any hazardous materials (e.g., lithium batteries), then the carrier already has the necessary documents for pre-approval of the transportation.

After all the parts have arrived at the Honda Aircraft location, the final product is assembled. This will create a transaction on the blockchain. Going forward, not all companies will need to be part of the blockchain. For example, GE Aviation can be replaced by Collins Aerospace.

The blockchain continues to be built as the project progresses: each flight is recorded as a transaction as are the documents along with each flight and the passenger manifests, if applicable. After some period, the tires must be replaced. By using a smart contract, Honda Aircraft and Collins Aerospace can be alerted when it is time to replace the tires based on the amount of use. The smart contract can be set up in a way that alerts Collins Aerospace to ship a tire to the next landing location of the aircraft because the smart contract can automatically communicate: “1 more landing before replacement required,” and Collins Aerospace, by using the blockchain, can identify exactly which tire needs to be replaced and where to send the replacement.

Additional benefits not explicitly mentioned in the use case:

- Efficiency is doubly important since components are worth tens of thousands of dollars
- Tamper-free, transparent records of each component that makes up a single aircraft are essential for record-keeping and maintenance
- To keep transactions and data secure, each block can be a hash and only the permissioned parties can “unlock” the hash to see the details
- By making Honda Aircraft the main party of this blockchain network, it can select specific companies to join the network, which keeps the liability contained and helps maintain a controlled environment
- The ability to data-mine from the blockchain can give statistics on performance per part.
- Blockchain provides accuracy in tracking and certification of authenticity

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Building a Blockchain-Enabled Honey Traceability System

By Joseph Cazier & Max Rünzel, Appalachian State University

Researchers at Appalachian State University in Western North Carolina have embarked on the creation of a honey traceability system that would verify the ability to write and retrieve data from a blockchain-distributed ledger tracing data about bees, beekeepers, and secondary data sources. The following use case is a practical example of how blockchain is being used in the agricultural space. These types of blockchain applications have an important benefit to rural communities where most beekeeping activity originates.

Problem

Honey is one of the most "faked" foods in the world, depressing honey prices for legitimate honey producers, limiting the producers access to markets, defrauding buyers, and putting consumer health at risk. A robust honey traceability system would provide a platform for a verifiable differentiation of honey sources, open new markets, ensure safe access to markets, offer product reliability to buyers, protect consumer health, and facilitate global development of small producers by unlocking the unique qualities of local, organic, fair trade, and varietal honey.

The rationale for a blockchain solution

The data required to track honey production would come from Apiary Management Software, Sensors (IoT), Secondary Data, Algorithmic Extrapolations, and Third Party Verification, as described below:

- Apiary Management Software (AMS): This software records contextual information about a beekeeping operation, including colony counts, locations, management actions, health assessments, queen genetics, and production and survivorship outcomes
- Sensors (IoT): This step involves the collection of automated data, mostly from inside the hive, and includes important bio-markers of hive health such as temperature, humidity, and hive weight. Colony location and colony disturbance would also be monitored
- Secondary Data: This step involves the collection of additional data from secondary data sources outside the hives, including weather, land use, flora taxonomy, and density, and bloom periods. These factors all affect apiary suitability measures for a given colony yard placement
- Data-Driven Algorithmic Extrapolations: This process takes the life science data from the sources mentioned above, adds to its secondary data, and uses algorithms to extrapolate the expected honey production for an apiary. It is an important step in the verification and traceability process to ensure production numbers are not inflated
- Third-Party Verification: This step importantly ensures honey integrity in the downstream supply chain, ensures the honey is not adulterated after production and confirms the source of origin. It would be done by honey testing labs with the data written to the blockchain and recorded in a producer rating system

In order to build a viable honey traceability system, the data needs to be trustworthy, verifiable, and shareable. Distributed Ledger Technology, often referred to as Blockchain Technology, offers a way to record data that is immutable. That is, once it is written to the blockchain, it can never be changed without being detected. This feature makes the data trustworthy from the time of recording.

Additionally, it provides a clear path to transparency as the ledger can be open and shareable. Together this makes the blockchain ledger the ideal place to record the data from the systems noted above in a trustworthy and accessible way.

III. Acknowledgements

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Ownum
Polsinelli PC
RYMEDI
Trust Stam

In addition to the industry webinars, the North Carolina Blockchain Initiative held a fact-finding mission to Washington, DC, for a series of policy and industry briefings. On January 30-31, 2020, a delegation consisting of three Co-Chairs and members led a mission aimed to gather details and data related to any progress that blockchain-based technologies are having within the scope of the federal government.

The NCBI delegates explored ways to enhance state and federal government collaboration with the emerging blockchain enterprise and startup ecosystem in North Carolina, and efforts to promote digital assets and blockchain-based technologies by educating others on the benefits they bring to the industry, government, and consumers.

The delegation fostered relationships with industry leaders, legislators, policymakers, and organizations with ties to North Carolina. The North Carolina Blockchain Initiative would like to acknowledge the following individuals and organizations for their time and advice.

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