What Blockchains Could Mean for Government and Transportation Operations

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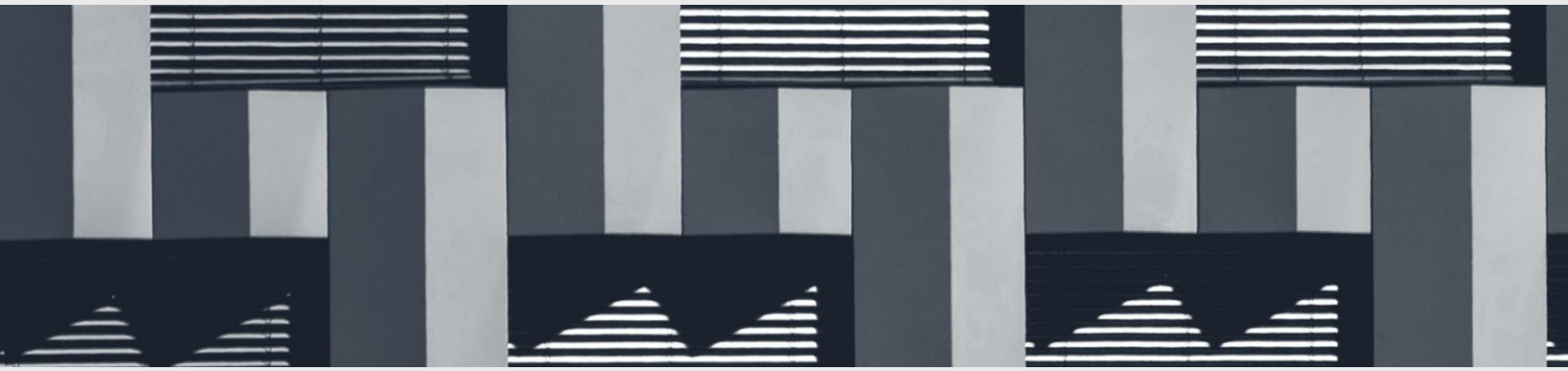

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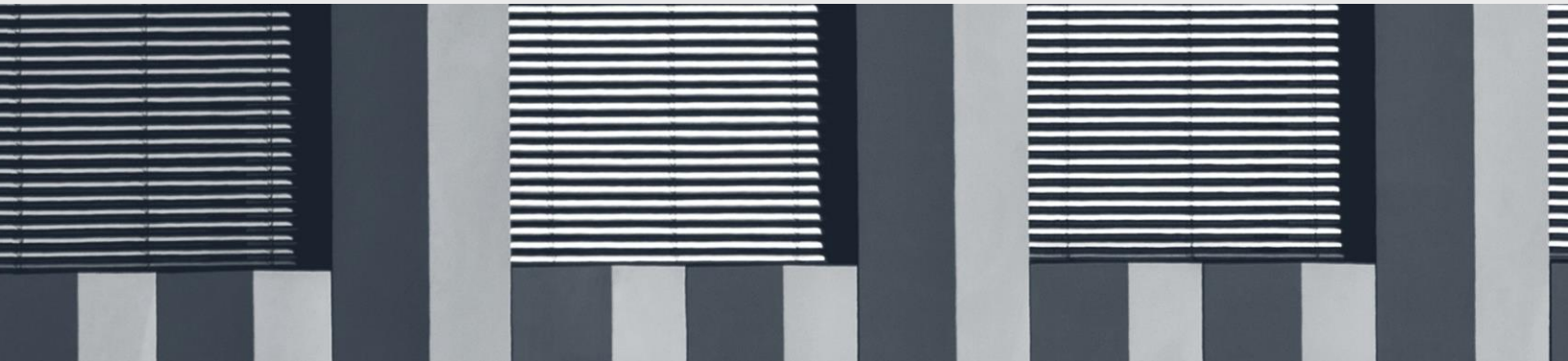


Notice

What are Blockchains and Why Do They Matter?

Physical safety features like watermarks and color-shifting ink make paper currency difficult to counterfeit. A **blockchain** is the digital analog to physical safety features on paper money. The blockchain concept was introduced in the late 2000s as the virtual scaffolding for transactions using the digital currency bitcoin. They prohibit a bitcoin from being spent more than once.[1] Blockchains are now being applied to a variety of industries, including transportation.

A blockchain is a digital, openly shared, and decentralized log of transactions. Every bitcoin transaction, for example, is stored on a blockchain that is continually updated across a network of thousands of computers.[3]

> "Everybody on the system can agree on exactly what happened and when it happened…I think that's a profound idea."
>
> -Joseph Lubin, co-founder of Ethereum blockchain platform.[2]

Here's a simplified example of how a bitcoin transaction is stored on a blockchain: Mary agrees to pay Tom one bitcoin for an oil painting Tom has been working on. The blockchain log verifies that Mary does indeed own the bitcoin and that she has not already spent it on something else. The blockchain holds information on the transaction history of Mary's bitcoin. Tom delivers his painting to Mary. Mary pays him one bitcoin. Tom now owns the bitcoin, and the blockchain gains another record.

A little etymology will help explain further. A blockchain begins with a record of a transaction or transactions. Records within the blockchain log are bundled into timestamped blocks identified by a cryptographic code. Each block is linked to the cryptographic code of the block that came before it. The links of cryptographic code form the *chain* of timestamped *blocks*: now we have a blockchain.[4] It is a chain because changes can only be made by adding a link—new information—to the end of it.[5]

Blockchains matter because they allow *non-trusting members* to interact over a network in a verified way, without a trusted intermediary.[6] The idea behind bitcoin was to remove banks from financial transactions.[7] Mary and Tom, for example, are able to engage in a financial transaction without traditional financial institutions.

The World Economic Forum estimates that by 2027, 10 percent of global GDP will be stored on blockchains. Today, global GDP is about $80 trillion, 10 percent of which equals about $8 trillion.[8]

Smart Contracts

Blockchains were made for finance. **Smart contracts** make blockchains applicable beyond finance, to industries like transportation.

> "It allows people to exchange value without knowing the identity of each other necessarily, in a secure way on the back end. On the front end, it's simplicity, transparency and trust. Think of all the cost, time and often waste that happens in the exchange of value—blockchain rids that from the system."
>
> -Jason Kelley, IBM's global manager for blockchain services.[9]

Smart contracts are software, not actual contracts. But, like a contract, they set parameters that parties to a transaction agree upon. Terms of the agreement are written directly into lines of code.[10] Smart contracts refer to a blockchain as a source of truth.[11] Before blockchains, smart contracts would not have been possible because parties to an agreement would have likely maintained separate databases.[12]

Say Mary wants to buy a house using bitcoin—in fact, the first residential property was recently sold using a blockchain.[13] A smart contract is applied to a blockchain that includes data on the house and Mary's bitcoin finances. The smart contract might say, "Mary will buy the house for 100 bitcoins." The smart contract references a blockchain to answer key questions: Does Mary have 100 bitcoins? Is the home available for sale? Does the seller legitimately own the house?

No central authority is needed. Smart contracts and blockchains allow transactions and agreements to be carried out among disparate, anonymous parties. Transactions are traceable, transparent, and irreversible.[14] Smart contracts can be simple or infinitely complex.[15] Intermediaries become redundant.

Applying Blockchains in Government

There are several proposed, ongoing, and theoretical ways of **applying blockchains in government**. An IBM Institute for Business Value survey of 200 government leaders from 16 countries found that 9 out of 10 governmental organizations plan to invest in blockchains for financial transaction management, asset management, contract management, and regulatory compliance by 2018. Seven out of 10 government executives surveyed predicted blockchains will significantly disrupt contract management, which is often where public and private sectors intersect.[17]

> "Blockchain technology is not a panacea; it's not the answer to every problem. But we're certainly hopeful that the State Department and the federal government can leverage this technology to make us more efficient and better able to serve the American people."
>
> -John J. Sullivan, Deputy Secretary of State.[16]

The U.S. Department of State has explored ways to use blockchain to improve efficiency.[18] The United Kingdom is experimenting with a system to pay benefits using blockchain. Australia is investigating ways to bring separate passport and birth certificate databases into a single blockchain system.[19]

Following the Equifax hack in mid-2017, there has been talk of replacing social security numbers with digital identifiers stored in blockchain networks.[20] The U.S. Postal Service and the Department of

Homeland Security are also researching how blockchains might be used to establish secure identity management.[21] The General Services Administration's Emerging Citizen Technology Office offers a Federal Blockchain program for federal agencies and U.S. businesses interested in how distributed ledger technology can be implemented within government.[22] The National Institute of Standards and Technology, an agency of the U.S. Department of Commerce, recently released a high-level technical overview of blockchain technology and applications.[23]

If there is an interaction between government and citizen that relies on multiple databases, that interaction may be streamlined with blockchains. Illinois is part of a pilot exploring the use of blockchains to transfer property titles, one of a number of blockchain initiatives the state is pursuing that could impact education, health care, and renewable energy.[24] The Delaware Blockchain Initiative is seeking to clarify state law and welcome the blockchain industry. Questions remain about how government entities will fit into peer-to-peer, decentralized transactions, and answers may be tailored on a use-by-use basis.[25]

Blockchains in Transportation

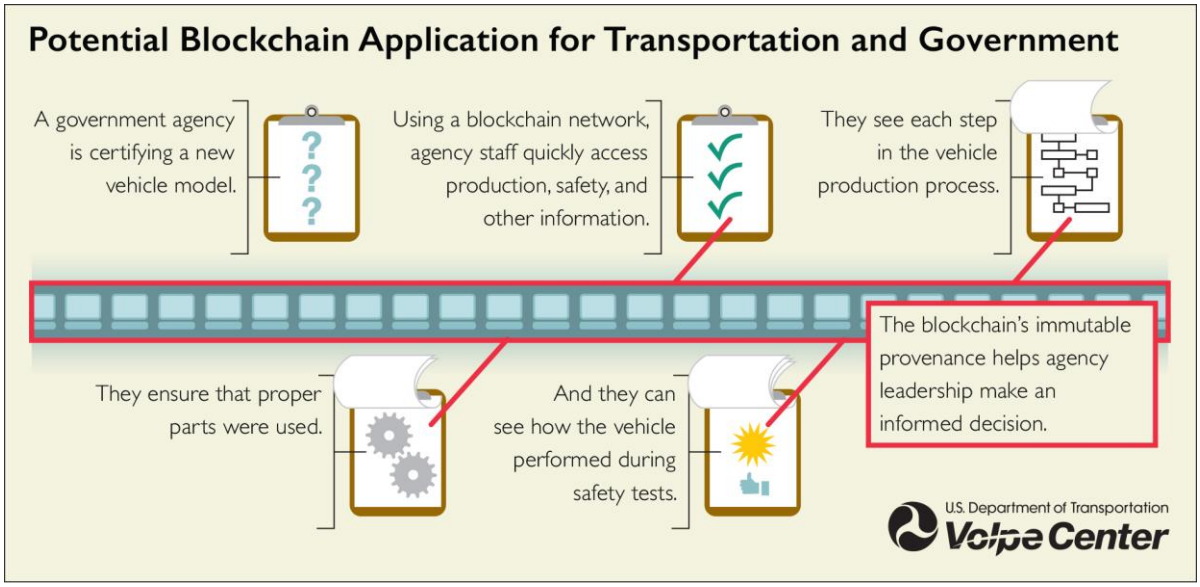
Experts across modes are exploring ways to use **blockchains in transportation**.

The **freight logistics** sector could benefit greatly from blockchains. Data transfers can be made more secure, and intermediaries can be removed from transactions.[27] Accident records, GPS and accelerometer tracking, weather information, crew information, inspection and certificate data, and mileage could all be stored on a blockchain. For a specific example, how people buy and sell used trucks could change. Members of a blockchain network could access previous ownership, maintenance, and tire records, speeding up transactions and ensuring equal information among participants.[28]

> "Through blockchain technology every transaction in the trucking ecosystem can be interconnected, providing the potential to dramatically change workflows and the way people do business for the better."
>
> -Mauricio Paredes, vice president of technology for PS Logistics.[26]

There is also the potential for digital, interconnected proof-of-delivery processes. Any business or government involved in moving goods could efficiently and securely update a shared, digital bill of lading—a blockchain. Parties could verify transactions as they occur, eliminating disputes about late or detained deliveries.[29] For a single transaction, a blockchain could be viewed by a manufacturer, shipper, customs personnel, government staff, drivers, and carriers, and might also include information on the raw materials to produce goods.[30] Because parties to a transaction can see exactly where goods came from, they can combat counterfeiting and monitor the quality of goods.[31] Some startups are using delivery GPS and smart contracts to pay suppliers and shippers just as merchandise arrives.[32]

Toll payments may also be made simpler with blockchains. One company recently demonstrated how a vehicle and a highway toll booth could be connected to make seamless payments using a blockchain, radio-frequency identification, and a filesharing protocol. This proposed system would be much less expensive than current toll road payment systems, which need large server infrastructures for accounting, identification, and payment processing.[33]



Ridesharing services like Uber and Lyft do not, strictly speaking, enable ridesharing. Those applications facilitate taxi hailing, and have expanded the definition of a taxi. Blockchains could enable true peer-to-peer ridesharing, where riders and drivers see in real time—without an intermediary application—who is offering trips, where customers are, pricing, and available seats.[34] La'Zooz is one blockchain-based ridesharing platform that, like bitcoin, is decentralized and owned by users—there is no intermediary between rider and driver.[35]

The Toyota Research Institute is prototyping the Ethereum blockchain as an alternative to ridesharing applications, through a recently announced consortium with the Massachusetts Institute of Technology Media Lab and other partners.[37] With blockchains, storage of vehicle data, such as usage, owner info, drivers and passengers, can be validated between two parties via smart contracts, eliminating intermediaries and transaction surcharges.[38]

> "The Volpe Center is well-positioned to consider how blockchain technology can advance the U.S. DOT strategic goals of safety, infrastructure, innovation and accountability. Our range of expertise means we can be a testbed for the department, and for others considering how best to pursue blockchain applications in transportation."
>
> -Regina Houston, Chief of Aviation Safety Systems Management at the U.S. DOT Volpe Center.[36]

As **autonomous vehicles** become popular and humans are removed from the controls, investigators may rely on black boxes for reliable information after incidents happen. A black box could be made secure from hackers, but cybersecurity is irrelevant if the black box can be removed and destroyed. A blockchain's inherent distributed database could provide information storage security.[39]

Blockchains will also find applications in aviation, including for aircraft maintenance, passenger and crew identity management, ticketing, loyalty programs, air cargo, customs clearing, flight planning, and more. For **flight insurance**, a smart contract would include the parameters of the transaction, such as the passenger, flight, and insurance premium acceptable to passenger and insurer. Some of this information would come from data sources outside of the blockchain, but in theory a flight insurance policy could be carried out without a flight insurance company.[40]

The Challenge is in the Execution

The blockchain concept is revolutionary, but **widespread adoption is not foregone**. Existing systems are among the biggest obstacles to blockchains. A few things that will need to come first: harmonized frameworks, education within industries, collaboration across industries, and proving the public benefit.[42] Groups like the Blockchain in Transport Alliance, which includes global logistics companies like UPS and FedEx, are working to develop blockchain technology standards and to educate the freight industry.[43] Currently there are no international or interstate agreements on how to regulate blockchain applications outside of finance.[44] Questions also remain regarding the sheer amount of energy it can take to run the computers behind a massive blockchain—there are now 300,000 bitcoin transactions per day, for example, and each transaction may use as much energy as an American household does in a week.[45]

> "Blockchain is inefficient tech by design, as we create trust by building a system based on distrust. If you only trust yourself and a set of rules (the software), then you have to validate everything that happens against these rules yourself. That is the life of a blockchain node."
>
> -Alex de Vries, cryptocurrency analyst.[41]

Blockchains are not a silver bullet. They can be more appropriately thought of as a tool to solve new problems.[46] As with most revolutionary concepts, the challenge will be in the execution.

###

Appendix A: Blockchain Initiatives in Transportation and Government

Blockchain in Transport Alliance
Formed by tech and transportation executives to create a forum for the development of blockchain standards and education for the freight industry. Their goal is to bring together leading companies in the freight technology industries that have a vested interest in blockchain technology.

La'Zooz
A decentralized transportation platform owned by the community that uses vehicles' unused space to create a variety of smart transportation solutions.

Project Oaken
Their vision is to produce an Internet of Things hardware and distributed software platform that powers smart cities, with automated machine-to-machine controls and a focus on toll payments.

The Delaware Blockchain Initiative
An outreach effort led by the governor and Delaware's Department of State to clarify state law and welcome the blockchain industry.

The Illinois Blockchain Initiative
A collaborative effort exploring blockchain's impact on government.

Toyota Research Institute and MIT Media Lab
TRI and MIT are exploring blockchain and distributed ledger technology for use in the development of a new mobility ecosystem that could accelerate development of autonomous driving technology.

U.S. Federal Blockchain Program
An initiative from the General Services Administration's Emerging Citizen Technology Office for federal agencies and U.S. businesses interested in exploring distributed ledger technology and its implementation within government.

World Economic Forum: The Future of Blockchain
This council is exploring how blockchains could impact industry, governments, and society, and is designing innovative governance models to ensure benefits are maximized and risks kept under control.

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This report provides a high-level overview of blockchain concepts and how they are being used in government and transportation.

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