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White Paper

The Application of Blockchain for State & Local Governments

Leveraging Revolutionary Technology to Better Serve the Community

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Improving Transparency and Efficiency in Government Data with Blockchain

For many, the word “blockchain” conjures images of get-rich-quick schemes and internet memes. The idea is tied inextricably to cryptocurrency (sometimes mocked as “magic internet money”) and promises that it can change the world without ever offering a specific plan as to how. Divorced from these popular conceptions, however, blockchain offers a fascinating and unique method for managing data and can be a very useful tool for governments.

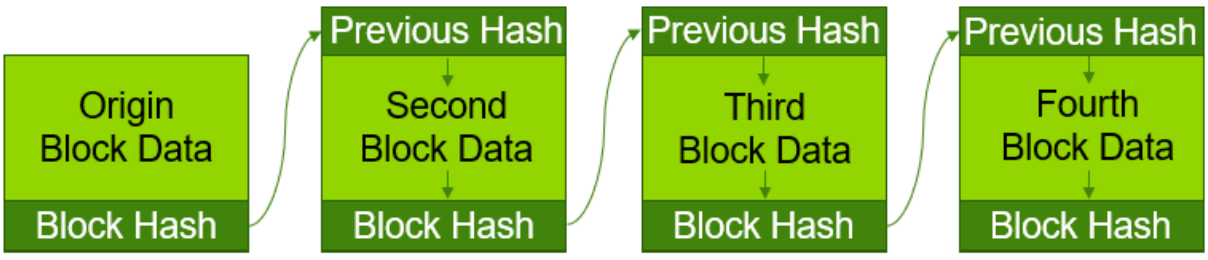
Blockchain is, at its core, a method for creating a database. These databases have unique features making them ideal for transparency and access to information. Monetary transactions, which permeate popular examples of blockchain, are one use case, but this linkage is unfortunate because the information handled by blockchains can be anything one wishes to preserve in a transparent way. This includes nearly all information managed by state and local governments, many of whom are already using blockchain for a perhaps surprising number of applications.

What Is a Blockchain?

To understand what a blockchain is, it can be helpful to forget what is already known and allow the subject to be recast in a new light. In its most basic form, **a blockchain is a way of storing and retrieving data—essentially a database or a ledger**. These databases are unique in that they ensure transparency by allowing anyone to view their contents, while at the same time keeping the data secure by implementing some clever tricks from cryptography. They can also store and react to data very quickly, allowing previously tedious data tasks to happen rapidly and in a publicly verifiable way. Once data is stored in this database, it cannot be changed directly, only amended by an additional entry in a way that creates a secure history of all the data that has ever been entered.

The name blockchain derives from its core functionality. Each chunk of data that is added to the database is referred to as a **block**. These blocks are added to the database one after the other, chronologically, and resemble a chain. Once accepted, each block is “signed” with a cryptographic proof that derives from all the unique data in that block. That signature, called a **hash**, is then used as a reference for starting the next block (see Figure 1).

Figure 1 Blockchain’s Cryptographic Hash-Based Security



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This way, anyone with a copy of the blockchain can immediately detect if someone has attempted to falsify historical data because the hashes of every block from the point of the change on will have been radically altered. In some cases, these changes will then be rejected automatically by the network of computers that contribute to the blockchain. This function of blockchain gives it a key characteristic known as **immutability**.

Cryptography also allows people to securely add information to the blockchain by utilizing something called a **key pair**. Anyone wanting to add data to the blockchain needs to sign their transactions to ensure they are who they claim. However, a simple digital signature, some string of letters and numbers, could be easily stolen since these signatures have to be publicly viewable. To prevent fraudulent data entries, each signature comes in two parts, each known as a "key." One key is the publicly known signature, but it is derived from a cryptographic hash of a private key. The nature of cryptography means that it is very easy for people to translate their private key through the cryptography protocol and generate the public key, but working backward from the public key to the private would be nearly impossible due to the enormous number of possibilities.[1] Because of this, people can ensure that anyone adding data to the blockchain is who they claim to be (so long as the private key is kept private).

What Kinds of Data Can Blockchain Handle?

Of course, data is only as valuable as the ways it can be applied. While early blockchains were designed to handle a single type of data, newer versions can work with surprisingly complex datasets. First-generation blockchains, such as Bitcoin, are simple read/write systems storing only one type of data. In the ensuing 15 years, blockchains have evolved to handle a wide array of data types through programmability, higher bandwidth, and faster data confirmation speeds.

Programmability in particular has greatly expanded the value of blockchain as a data management and transparency tool. On programmable blockchains, anyone can write programs, known as **decentralized applications (dApps)**, to allow the blockchain to store virtually any type of data in virtually any structure needed for their intended use case. Today, dApps have been used to leverage blockchain for everything from public real estate record management[2] to supply chain validation.[3]

There are also tools to help blockchains overcome issues posed by their enclosed data architecture. Blockchains can only reference data that has been specifically added to them, which improves data integrity but limits use cases where outside information (like sensor readings) are critical for dApp operation. A special type of blockchain called a **data oracle**, which sits between the blockchain and outside data, can safely bridge this gap. Similarly, a type of blockchain commonly called a **layer zero** can facilitate interoperability between different blockchains that otherwise have no way of exchanging data.

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[1] Muhammad Zubair, "How Is SHA-256 Used in Blockchain, and Why?" Educative, 2023, **https://www.educative.io/answers/how-is-sha-256-used-in-blockchain-and-why**.

[2] Joanne Cleaver, "Could Blockchain Technology Transform Homebuying in Cook County—and Beyond?" *Chicago Tribune*, July 9, 2018, **https://www.chicagotribune.com/real-estate/ct-re-0715-blockchain-homebuying-20180628-story.html**.

[3] Ledger Insights, "Tencent, Fidelity Backed Everledger Launches Blockchain Bottle Closures for Wine Industry," April 20, 2020, **https://www.ledgerinsights.com/everledger-blockchain-bottle-closures-wine-anti-counterfeit/**.

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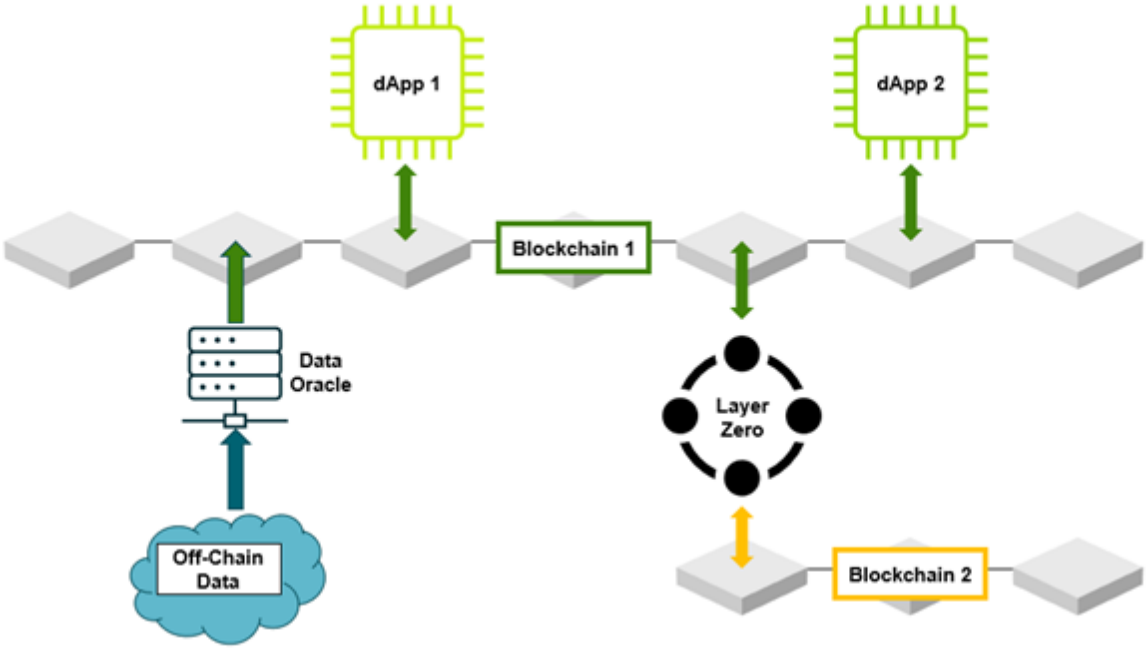
Figure 2 Data Flows between Blockchain Types



(Source: Guidehouse Insights)

Unique and Useful Features of Blockchain for Governments

Various governments have already utilized blockchain to improve access to public services by socially isolated or unhoused citizens, to build a record of air quality readings,[4] and to incentivize citizen engagement through discounts at local businesses.

Three features inherent to how blockchain stores and displays data make it valuable to governments:

- **Immutability:** Information within a traditional database has an inherent flaw in that it can be altered at any time, potentially without an easily viewable record. With blockchain, once data is included in a block and published, it is permanent. The data may be amended in the future, but any attempts to rewrite the past are easily identified and rejected.
- **Transparency:** The architecture of blockchain is such that everyone can view the full record and compare it to their own copy at any time. This transparency, paired with the data's immutability, makes blockchain ideal for publishing public records. Access to information is easier, more secure, and requires less effort from records departments (such as processing requests).
- **Programmability:** Since many blockchains can now store multiple types of data through programmable dApps, governments have a large degree of choice in how they store and display their public information. Data oracles and layer zeros can also extend dApp functionality.

[4] Grant Samms, "Miami Is Building a Blockchain-Based Air Quality Ledger That Rewards Citizens," Guidehouse Insights, April 22, 2022, **https://guidehouseinsights.com/news-and-views/miami-is-building-a-blockchain-based-air-quality-ledger-that-rewards-citizens**.

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What Can Blockchain Do for State and Local Governments?

Government entities are data-rich bodies, but organizing and utilizing that data often poses a challenge. Each functional department generates data that is public information by policy or law, and open access must be provided in some way. This openness is a hallmark of democracy, and blockchain can be a powerful tool to not only store data in a way that is easily accessible but also assert its authenticity.

The benefits of using blockchain for government data include the following:

- **Ease of data recording and access:** Since the data recorded on a blockchain is publicly visible, information can be quickly shared between departments and with the public. This can reduce time and staff resources spent on handling information requests. In some cases, data can be automatically inscribed on the blockchain, further reducing staff time.
- **Data security:** Blockchain confers a level of self-evident authenticity to data due to its immutability. This secures records against tampering and can reduce the need for auditing. Since anyone can view the blockchain and compare it to past versions; any attempts to alter historical records are readily identified and can be rejected.
- **Records task automation:** Certain processes of both publishing and utilizing data can be automated with blockchain, which frees up staff time and other resources. Especially when data oracles and dApps are used, ideas become possible that would otherwise require a prohibitively large amount of staff time or expense to execute—for instance, incentivizing citizens to help build a record of local air quality.
- **Greater trust in government:** Because of the transparency and immutability of data on blockchains, citizens can be assured that historical data on the blockchain is the same today as when it was recorded. Records cannot be lost or altered, which can assuage citizen fears of fraud or corruption in public recordkeeping.

Blockchain Considerations Relevant to Governments

While blockchain offers state and local governments a powerful tool for data management, care must be taken in its implementation. As an inherently neutral tool, blockchain can be used in ways that either build trust in institutions or damage it. Governments should be aware of a few key issues and distinctions in order to achieve the best possible outcomes from blockchain adoption:

- **Choice between distributed and private:** Governments looking to implement blockchain as a data management tool must make the critical decision of whether to use a public, decentralized blockchain, or one that is privately hosted. Using a private blockchain can simplify some aspects of project management, but it also damages the immutability principle, since the government controls all the data and can alter it at will. Outsiders could detect only that a change had occurred, setting up a potential conflict about why public information was altered. If data is entered on a public, distributed blockchain (such as Ethereum or Algorand), such alterations are not possible. Governments must give up a measure of control, but they gain trustworthiness and transparency.

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- **Trustworthiness of involved parties:** While data that is inscribed on a blockchain is immutable, its inclusion on a blockchain should not be taken as an endorsement of its accuracy. Blockchain cannot control for sensors being miscalibrated, data being incorrectly entered, or records being falsified outright before they are added to the blockchain. Because of this, it is important to maintain high standards of data collection and handling.
- **Concern over proper implementation:** A conventional data center has a database administrator whose job is to provide or deny access to database information as appropriate. With blockchain, this function must be done properly in the initial phase, as once data is published to a blockchain, it is public and immutable. This may garner concern from technology skeptics.
- **Incorporation into existing solutions:** Many state and local governments buy customized packages for municipal projects from third-party solutions vendors. Some of these solutions already incorporate blockchain technology for data storage and security, but this feature may or may not be highlighted to government customers.

Examples of Blockchains in Use by Governments

Because blockchain is a new and emerging technology, descriptions of its inner workings may sometimes obscure the unique role it can play in municipal operations. Guidehouse Insights tracks a number of government projects that have utilized blockchain, including the following:

- **Unhoused identity services in Austin, Texas:** The city of Austin launched a pilot in 2018 to digitize and encrypt records for unhoused people and used blockchain to tie records to a person's biometric identity.[5] A person's private key is a biometric, like a fingerprint, and the cryptographic hash of that biometric verifies their identity when interacting with government services. In 2021, a research team at the University of Texas at Austin began adapting the pilot to similarly simplify health records for the city's unhoused population.[6]
- **Peer-to-peer energy trading in Da Nang, Vietnam:** As the business of energy production becomes ever more distributed in the era of renewable energy, it is critical to accurately track the rapid flows of energy between parties. In Da Nang, the local power company began piloting blockchain in March 2023 to simplify recording rooftop solar generation data and energy usage across households.[7] The company's hope is to provide greater transparency on energy pricing while capturing data on solar intermittency that can help lower costs in the future.
- **Record of historic places in Reno, Nevada:** The immutability and transparency of blockchain are features that the city of Reno is keen to bring to many of its municipal records. Starting in 2022 with its register of historic places, the blockchain portal on the city's website allows residents to quickly find information on specific buildings, see how that information has been amended, and request new amendments.[8]

[5] Danny Crichton, "Austin Is Piloting Blockchain to Improve Homeless Services," TechCrunch, April 14, 2018, **https://techcrunch.com/2018/04/14/austin-is-piloting-blockchain-to-improve-homeless-services/**.

[6] Nicole Villalpando, "UT Austin Developing Blockchain ID for Homeless Health Care," *Government Technology*, May 11, 2021, **https://www.govtech.com/education/higher-ed/ut-austin-developing-blockchain-id-for-homeless-health-care**.

[7] Jonathan Spencer Jones, "Vietnam Electricity to Pilot Blockchain P2P Energy Trading," *Smart Energy International*, March 30, 2023, **https://www.smart-energy.com/digitalisation/vietnam-electricity-to-pilot-blockchain-p2p-energy-trading/**.

[8] Galena Hill Inc., City of Reno Register of Historic Places, **https://int-renopublic.azurewebsites.net/**.

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Conclusions and Recommendations

Due to blockchain's nascency, popular understanding of its utility has been shaped in an overly limited way. For governments, blockchain's unique features for building immutable, programable, and transparent datasets make it a compelling tool for securing public records. However, **governments should acknowledge that many citizens may be confused about the capabilities of blockchain technology and that some education may be necessary.**

Third-party application vendors should also be actively encouraged to implement blockchain within their offerings. By incorporating blockchain into their existing solutions, vendors can help cities increase trust in record validity, make records easy for the public to access, and even automate certain aspects of municipal functions that are otherwise time intensive.

Of course, care should be taken when implementing blockchain applications. Just as blockchain is not well described as merely a fad for buying and selling silly pictures, it is also not accurately framed as a panacea. Blockchain is a tool for storing and securing information, but it does not assure the accuracy of the information, only the validity of the person who entered it. **State and local agencies should be open-minded about how to implement this tool in order to secure blockchain's benefits and be willing to accept that a few citizens may be confused.** When implemented carefully, blockchain can help governments solve problems that have proven historically difficult. Because of its unique features, blockchain should be considered by governments as a valuable tool available to them when managing the vast amounts of data they encounter every day.

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