Microsoft pwc VERTEX

Blockchain for tax compliance

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01.

Executive summary

Much has been said about the promise of blockchain and distributed ledger technologies (DLT). The interest and association with cryptocurrencies can lead many to question the legitimacy of those promised benefits. Yet successful pilots and projects in industry and government agency alike, with measurable and tangible results, are starting to emerge.

Efficiency, accuracy and transparency are being enhanced through the application of these technologies. In the government sphere, the initial results are most readily evident in areas as diverse as information security and identity, land registration, evidence validation, transfer payments and voting.

An important question is whether blockchain and DLT can provide real benefits in the area of taxation. Where might these technologies be applied to reduce noncompliance and fraud, raise revenues and lower administrative cost and burden? What might potential solutions look like, how might they function and how can we test them on a limited scale and budget to prove the benefits?

But before we address those questions, we need to address some other key questions:

- What are the challenges in monetary terms – what's at stake?
- How can blockchain/DLT technology help – what's different about it?
- What are the risks and rewards associated with its adoption?

In order to provide guidance and support in answering these questions, the European Parliament's Special Committee on Financial Crimes, Tax Evasion and Tax Avoidance has published a draft report on November 14, 2018.[1] This report contains recommendations on fighting VAT fraud. Based on the VAT collection figures available, the total amount of VAT lost across the EU in 2016 is estimated at EUR 147.1 billion.[2] The revenue loss is due to tax fraud, tax evasion and tax avoidance, but also due to bankruptcies, financial insolvencies or miscalculations. The main cross-border VAT fraud happens when a fraudster does not claim and pay VAT due and accumulates the cash profit. Therefore, the report calls on the Commission to analyze the proposal **to place cross-border transactional data on a blockchain** and **to use a secured digital currency that can only be used for VAT payments** (single purpose).

Money at stake: Tax gap and administrative costs

The two best known tax gap estimates are the VAT gap in the EU, which is estimated at around €150 billion, and the US IRS gap, estimated at $458 billion. With a combined total of European VAT and US IRS revenue totals of approximately $4.6 trillion in 2016, the gap is 14%. If we simply gross up based upon the assumption that other taxes and other countries have the same tax gap on a percentage basis, we come to an estimated global tax gap estimate of $1.6 trillion compared to global tax revenues of $11.3 associated with GDP of $75.5 trillion.

On the administrative side, the Tax Foundation estimates $409 billion for US federal income tax compliance costs. A straight global gross up comes to a $1.3 trillion taxpayer administrative cost estimate. Combining the two yields **$3 trillion at stake**. This estimate may be high when one considers that US income tax is more burdensome than most other taxes and jurisdictions. Alternatively, it may be considered low were we to include the budgets for administrative costs at tax authorities around the globe. Regardless, addressing even a portion of this opportunity would result in large benefits for taxpayers and tax administrators alike.

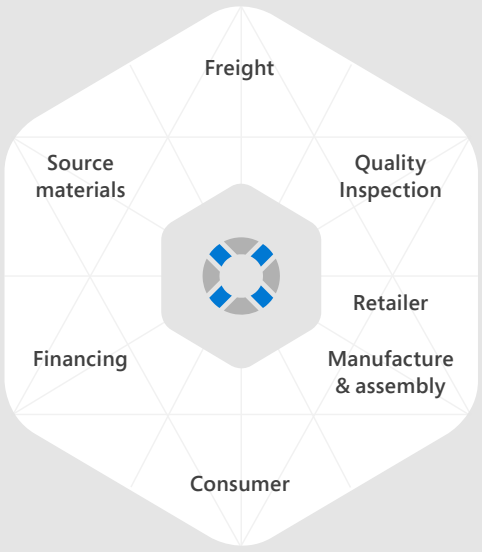
This white paper will explain how taxing authorities can leverage blockchain technology to reduce the tax gap, improve compliance and assist in the digital transformation of governments.[3]

02.
Introduction

Technology has affected how we do business. At the same time, business is built on trust between parties — customers, suppliers, retailers. Increasingly, delivering differentiated value to end users means collaborating and transacting across organizations. To achieve this, businesses trust these organizations to meet their obligations as stipulated, and to handle your customer data or physical assets with care.

Traditionally we build trust in transactions, specifically, in a couple of ways. We have intermediaries who broker trust across parties by centralizing relevant data to verify individual claims as a trusted third party. We might have intermediaries hold onto assets while those claims are being verified. For this service, the intermediaries charge a fee and sometimes slow things down. We might go through a manual verification process to make sure that our records are complete and accurate. These are important processes; they serve an important purpose. But they can be slow and expensive, and introduce friction into the transaction.

Property purchase



Industrial supply chain

Trade finance

Governments and private sector companies may improve trust in their transactions in order to:

- **Reduce cost:** Remove friction and allow direct interaction between parties.
- **Mitigate risk:** Reduce information security threats from fraud, hacking and data manipulation.
- **Increase speed:** Use a shared data source for transparency across organizations and increased end-to-end speed.

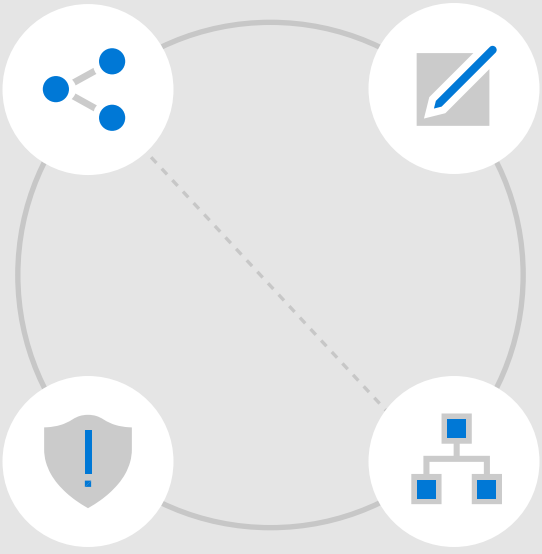
Blockchain offers an alternative: an immutable, distributed ledger.

Blockchain establishes a secure, shared source of truth:

- Data is stored in a ledger—a record of every transaction
- Full participants in the network exchange information to achieve an individual, identical copy
- The ledger is updated with the participant's agreement, and information can't be altered or deleted without the knowledge of the whole network.

Shared
Blockchain value directly linked to the number of organizations or companies that participate in them. There is a huge value to even the fiercest of competitors to participate with each other in these shared database implementations.

Secure
Uses cryptography to create transactions that are immutable to fraud and establishes a shared truth.



Ledger
The database is "write once" so it is an immutable record of every transaction that occurs.

Distributed
There are many replicas of the blockchain database. In fact, the more replicas there are the more authentic it becomes.

What will be the first use cases for Public Sector?

Ownerships

- Land registries
- Property titles
- Other physical assets

Identities

- Blockchain e-identities to citizens
- Use services like voting
- Healthcare records

Verification

- Licenses
- Proofs of records (degrees, grades, etc.)
- Transactions
- Processes or events

Movement of assets

- Transferring money from one person/entity to another. Enabling direct payments, once a work condition has been performed.

Credit: William Mougayar, author of "The Business Blockchain"

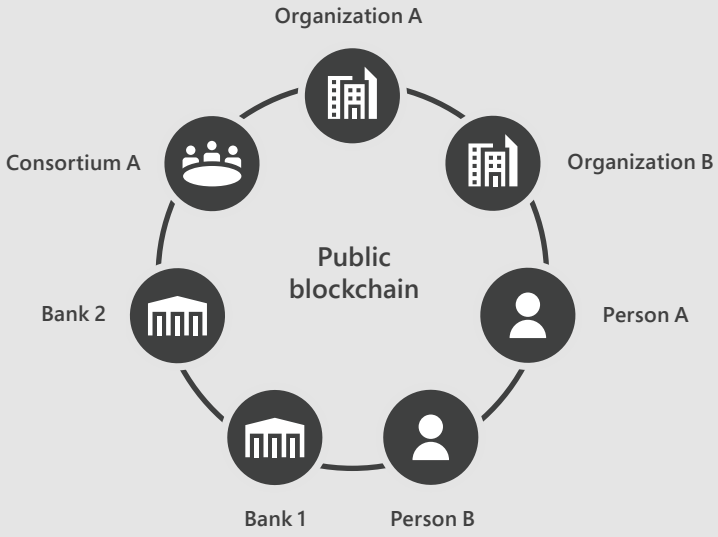
Blockchain network types

There are two big categories of blockchains: Public and Enterprise (also known as federated or permissioned blockchains). Within Enterprise Blockchains, we can differentiate further: Private Enterprise Blockchains or Enterprise Consortium Blockchains:

Public:
Participants can access and download the data stored on the blockchain. This blockchain (like Bitcoin or Ethereum) is an internet protocol that manages the distribution of data that:

- Acts as a unit of account for transactions on that ledger
- Incentivizes early adopters and developers to use, support and verify the ledger without the need for a trusted intermediary

However, these large public blockchains are currently required to consume a large amount of computer resources and electricity because they use Proof-of-Work consensus.[4] Furthermore, the speed of processing is limited because transactions must be grouped and added to the blockchain ledger after validation and Proof-of-Work. While energy consumption may reduce, and speed may increase over time, existing public blockchains will likely remain a poor choice for most government applications.



Free entry. Many, unknown participants - anonymous or Pseudonymous.
Open, read and write by all participants.
Consensus by proof or work.

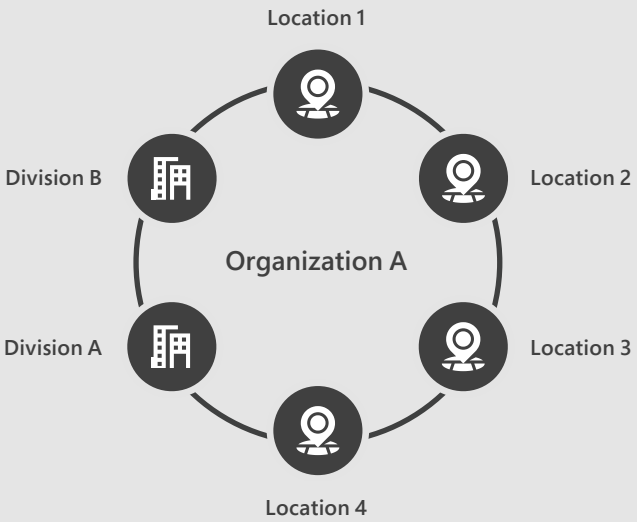
Enterprise blockchains:

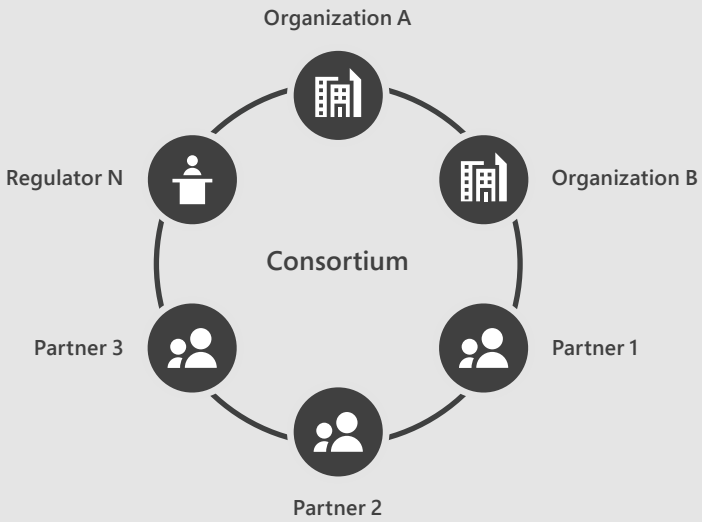
Only known parties can participate because permissions provide barriers to entry. Select parties get copies of specific data. Generally, participants are identified.

- **Private Enterprise Blockchains:** accessible within a single organization
- **Enterprise Consortium Blockchains:** Several organizations need to collaborate

The degree of information security in private networks is reduced since parties are known to each other. Similarly, approving transactions via alternative methods of consensus may not require large amounts of electricity and the speed of processing could be higher.[5] The private networks will likely remain the choice for most government applications.

In distributed systems, there is a trade-off among decentralization, speed and information security. To increase one, you must decrease another. Recent innovations focus on linking multiple blockchains together to gain speed via parallelization without reducing decentralization or information security.





Gated entry. Approved participants. Users with known identities. Permission is required to write, read, and participate in confirming transactions. Multiple algorithms for consensus.

Distributed ledger vs. blockchain

The terms blockchain and distributed ledger are often used as synonyms as we have done in this whitepaper. Blockchains are a type of distributed ledger.

Distributed ledgers are a form of distributed computing that consist of multiple copies of a database that are kept in sync with each other automatically. All copies of the database process new transactions to ensure they are valid given the rules of the system. The various databases communicate to ensure some consensus; at least 51% agree that a transaction is valid in terms of rules compliance before it is accepted. Distributed ledgers can be used to move information and ownership of digital assets. Tangible assets, can be open public systems or private closed networks, and can have all data exposed to all participants or have privacy-enhancing features.

Blockchains are distributed ledgers, but they also add in the ability to bundle transactions together in a way that links them to prior history, thereby enhancing information security and reducing the need for trust between participants. This is especially important when moving money in open networks with unknown counterparties, as you want to ensure that good funds are available at the exact moment of transaction conclusion. It is through this chaining of transaction bundles, or blocks as they are called, that blockchains prohibit the ability to modify past history, including past spending. Distributed ledgers that are not blockchains are more likely to be deployed in a private, privacy-enforced network among parties with some degree of trust.

For public blockchains, where parties don't have pre-established trust relationships, designers must program incentives into the blockchain to encourage behaviors supportive of that blockchain's specific goals, be that the overall advancement of the blockchain network value, or paying the right amount of taxes. By comparison to distributed ledgers, blockchains are more likely to be deployed in public, open networks or private networks lacking trusted counterparties.

To summarize, distributed ledgers are the evolution of high-volume distributed computing, and today are generally used between organizations with some degree of trust between them. Blockchains are a type of distributed ledger that uses incentives to overcome the lack of preexisting trust relationships between transacting parties. The emerging trend, one expects to play out for the next 12-24 months, is for blockchains to challenge non-blockchain-distributed ledgers for speed, and then scale that speed for use in enterprise-scale organizations while maintaining their ability to decentralize trust and incentivizing desirable user behaviors.

03.

Considerations for implementing a government blockchain

A fundamental purpose of government is to maintain the trust of its constituents. Under this imperative, a government should strive to demonstrate accountability through transparency. Furthermore, Public Sector operates at the intersection of many stakeholders: constituents, NGOs, private enterprises, and other jurisdictions. The role of government and its responsibilities are aligned with the distributed trust of a blockchain.

Public Sector is also responsible for the efficient management of public funds, including reducing the use of intermediaries. Given the significant financial role of government, Public Sector at the federal, provincial, and municipal level acts as trusted intermediaries and stewards of public record in a wide range of areas including registries, permits, claims adjudication, voting, copyright and trade. Public Sector is also a trusted steward of confidential records in the areas of identity management, health, education and electoral processes. However, these roles require confidentiality.

There are several such considerations to be considered when implementing a government blockchain:

- **Data sovereignty and related concerns**
  Storing data on a public blockchain provides security and transparency benefits. However, a Public Sector might be wary of security and transparency for multiple reasons. For example, many Public Sectors have data sovereignty laws that restrict storing constituent data outside the country boundaries.[6] Public blockchains replicate transaction data to nodes all over the world and result in storing government or constituent data outside of the borders of the country. Of course, the data itself can be encrypted, or the blockchain designer can choose to store only markers to the data stored elsewhere (hashes of the data), which is a typical approach for blockchain.

- **Strategic control**
  A public blockchain can reduce the government's control over the future of the network. As in the case of Ethereum and Bitcoin, the software underlying the protocol may be edited, resulting in a "fork" that can be adopted selectively by participants. From a government perspective, this unpredictability and lack of control may be a concern, especially when investigating public blockchains, if the choice or vote of a single government cannot realistically influence the direction of the chain.

  With these concerns in mind, a Public Sector looks at the option of building a private blockchain (such as a Private Enterprise blockchain discussed earlier) or consortium blockchain (such as an Enterprise Consortium Blockchain discussed earlier). But these also come with caveats. Building a completely private blockchain, or even a consortium blockchain, can undermine the transparency benefit of blockchain.

- **The privacy balancing act**
  Preserving privacy is a major concern for the Public Sector worldwide. Privacy on the blockchain is an active research topic with many alternatives being proposed. The simplest and most commonly used approach is to ensure that whatever is published on the blockchain is not published in clear-text form. Rather, it is either published in encrypted form or as cryptographic hash, or a combination of both. A hash of the data is typically a unique fixed-sized set of bytes that is

derived from the data, and cannot be reverse-engineered to get the original data piece but can attest to the validity of the original.[7] Technical advancements, such as multi-party computations and zero knowledge proofs, allow users to selectively share part but not all of their data to selected users.

- **Digital currency dependency**
  One of the main uses of blockchain is the transfer of value, or payments, between parties. Some public blockchains create cryptocurrencies such as Bitcoin or Ethereum and can support custom coins or tokens. In a government context, however, using cryptocurrencies might not be acceptable. Therefore, governments would look to link blockchains to their national "fiat" currency, or engage in issuing their own digital currency, which is an ambitious initiative that some governments like Canada[8] and Bermuda[9] are already exploring.

- **Identity management**
  Public blockchains typically do not identify participants. While this might be desirable in a government context, especially when privacy is needed, it is not necessary for all scenarios. For example, launching a blockchain-based land registry could include mapping lands to specific identities that are verifiable in the court of law. Therefore, identity management on this type of blockchain is critical. Public Sector can take advantage of the identity management properties of blockchain to ensure that these identities are not only mapped to blockchain addresses, but also secure and immutable.

- **Third party verifiability**
  A key benefit of blockchains is transparency. Transparency is available when participants validate the transactions using the method defined in a consensus protocol. Although government agencies can validate the transactions, there is a benefit to using third parties, which add to the credibility and protection from corruption. Such decentralization is more common in public blockchains. However, in private blockchains, this can be a concern that needs to be addressed.

- **Securing off-chain interactions**
  Blockchain participants validate each transaction submitted to the blockchain. Some government transactions may require additional validation off the chain. If such validations are not properly secured, then transactions stored on the blockchain may be falsely assumed valid by the blockchain. It is important that the government ensures that the whole processing cycle for transactions is secured and does not leave loopholes in the process.

- **Scalability**
  The Bitcoin scalability problem refers to the discussion concerning the limits on the amount of transactions the network can process.[10] It is related to the fact that records (known as blocks) in the blockchain are limited in size and frequency. The scalability of blockchains is one of the hottest research topics, and it needs to be considered when a Public Sector is making blockchain decisions, especially if the scope of the deployment spans the whole government, and the government has a large constituency.

- **Cost and rewards**
  The cost of processing transactions and maintaining the integrity of public blockchain is mainly born by validators, who are rewarded for investing their resources to validate transactions, and by fees and inflation born by participants submitting transactions. Private blockchains do not require the traditional costs of public chains but do require that the software and network be maintained. A government may also need a cost-sharing model for providing the services that process and secure transactions.

- **Political, legal and regulatory considerations**
  There are many political, legal and regulatory considerations that need to be evaluated, and this would depend on the actual government solution being considered for the blockchain.

Data classification and governance are paramount on embarking to the blockchain journey

Data classification is the process of sorting and categorizing data into various types, forms or any other distinct class. Data classification enables the separation and classification of data according to data set requirements for various business or personal objectives. It is mainly a data management process. A role model in the government data classification, starting 2nd of April 2014, UK Government has adopted a simpler approach of three levels of security classification: OFFICIAL, SECRET and TOP SECRET. The OFFICIAL classification covers up to 90% of Public Sector business, including most policy development, service delivery, legal advice, personal data, contracts, statistics, case files, and administrative data. Security controls at OFFICIAL are based on good, commercially available products, in the same way that the best-run businesses manage their sensitive information.[11]

Data governance is the exercise of decision-making and authority for data-related matters. All organizations need to be able to make decisions about how to manage data, realize value from it, minimize cost and complexity, manage risk, and ensure compliance with ever-growing legal, regulatory, and other requirements.

So then what exactly **is Data Governance**? In summary **Data Governance is**:

- A strategic program where data policies are identified, evaluated and data solutions are prioritized.
- Where key decisions about Information Management are communicated.
- A vehicle to ensure compliance and establish accountability around defined data policies and standards.
- Involvement of data owners and data stewards with broad understanding of the data required for a set of business processes.
- Development, institutionalization and socialization of policy, data standards, and information management processes.

Three common misconceptions

Despite existing success stories in blockchain, the public still holds common misconceptions. We highlight and discuss three notable misconceptions below:

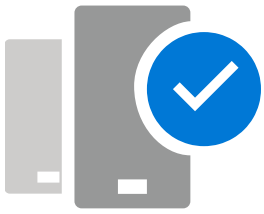
1. Data security and privacy are nonexistent. A common misconception is that data stored on blockchains is all publicly viewable and not secure or private. This is not necessarily true. In fact, blockchain technologies are being used within government and private industry to enhance data security and privacy. Existing database and application security are being enhanced through blockchain's combination of integrated digital signatures and unalterable audit logs. For data stored within the blockchain, privacy-enhancing access controls help ensure a high degree of data security and privacy.

2. Scalability is lacking. The need to flow transactions in real time to support continuous audit requires high transaction throughput. Currently neither Blockchain nor their DLT cousins can scale beyond tens of thousands to hundreds of thousands of transactions per second. Speed is necessary to process the large number of taxpayers and transactions in a regime such as VAT. Achieving these speeds today would require a more centralized and less secure approach than might be acceptable for broad scale taxpayer rollout.[12] However, today's speed can be sufficient for pilot programs with select taxpayers or tax types as we await the benefits of the massive investment and research being conducted on enhancing the performance of these systems.

3. Blockchains imply use of cryptocurrencies. Blockchain is the underlying technology that powers both cryptocurrencies and a large set of other use cases from voting to supply chain. It might be useful to think of blockchain as the internet and cryptocurrencies as the first major application, email. Email today is just one application. Cryptocurrencies are the first use case for many people for blockchain technology.

04.

Blockchain and tax compliance



The key concept behind both blockchains (and DLTs in general) is that they allow multiple parties to share information and transact in a way that each can gain assurance that mutually agreed upon rules have been enforced. A myriad of design possibilities exists. The key to them all is that the technology requires that each transaction comply with rules designed into the system that are transparent and agreed to by all participants. For example, in Bitcoin or Ethereum, the core rules necessary to execute a transaction to move cryptocurrency are 1) the sender has the private key to the account, and 2) there are funds sufficient in the account to make the transfer. Any transaction that adheres to these rules can be executed. Thus, each blockchain is described as a "protocol."

In other words, the system enforces compliant behavior in a way that is verifiable. It is a way of creating a "secured chain" framework as envisioned in the OECD publication Tax Compliance by Design.[13] In our view, the five key functional attributes of the technology relevant for implementing a blockchain solution for tax compliance are:

- Secure identity of people and things
- A distributed database for information exchange
- A real-time payment mechanism
- A means of distributing tax rules and regulations
- A means of continuously monitoring compliance verification

Together, these five capabilities enable a prepackaged and more secure solution for tax compliance.

Tax compliance through identity and security

The ability of a secure digital identity to be affixed to any entity or object, real or digital, and then have the identity's transactions and movements logged securely into trusted ledgers opens potential solutions for tax policy and administration.

Jennifer O'Rourke, Illinois Blockchain Business Liaison[14], recently remarked, "Basically all our use cases boiled down to identity." Indeed, identity is critical to the ability to enforce compliance with regulations and assess tax liability. Blockchain/DLTs use public/private key[15] security, commonly referred to as digital certificates, tied to an account or object (real or digital) for identity.

Digital-certificate-based security has been around for decades, and most people have used it even if they did not know they used it; for example, when shopping online at secure websites starting with **https://** or when signing electronic documents using DocuSign or other similar tools. What differentiates blockchain is the requirement that every transaction, every communication, every payment be signed by the account owner or it is rejected.

To assign a digital certificate to each taxpayer to enhance the security of communication, information transmission and tax payments, only the holder of the certificate can transact on behalf of the associated account.

In reality, these digital certificates reside on the computer systems from which transactions are initiated rather than being associated with an individual taxpayer. Therefore, in the longer term, blockchain designers should be focused on creating digital identities for "things." Cheap near field communications and RFID devices as well as a variety of sensors are being used to connect the physical world to blockchain/DLT based records.[16] The expansion of devices as part of the Internet of Things may require digital ID and the ability to transact with each other. Tax blockchain applications may attach and recognize identity for POS devices, goods in transit, intermediaries, tax stamps, etc.

Programs for identity management and security thereof are key pillars to any digital transformation, be it with blockchain/DLTs or otherwise. Design considerations include how to help taxpayers manage their digital certificates and how to select an appropriate certification authority process for issuance. Fortunately, given the proliferation of this technology in other areas, there are a myriad of security best practices that are available, including those pioneered by Estonia[17] as well as an emerging industry of key custodians.

Tax blockchain applications may attach and recognize identity for POS devices, goods in transit, intermediaries, tax stamps, etc. The ability of a secure digital identity (1) to be affixed to any entity or object, real or digital, and (2) then have its transactions and movements logged securely into trusted ledgers, opens potential solutions for tax policy and administration.

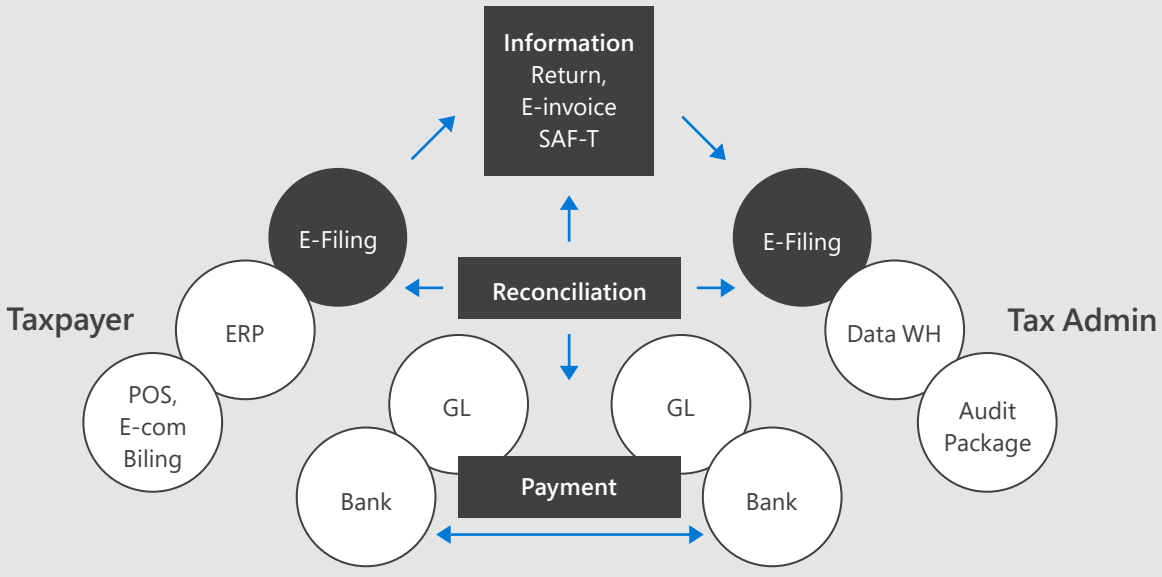
Tax compliance and information

The current approach to taxation involves three separate processes: information, payment and reconciliation. These processes are disconnected in terms of sequential timing, as first information then payments flow, and reconciliation occurs periodically to keep them in sync. In addition, these processes are conducted in isolation by both the taxpayer and the tax administration.

In the examples below, we have used VAT for the basis of illustration. These concepts may also be applied to payroll tax, property tax, fuel and excise tax, luxury goods tax stamps, and to a limited extent, even income taxation. While these examples are illustrative only, they do provide a good foundation for initial discussions around the appropriate design of a digitally transformed tax administration. We look forward to engaging with tax administrative agencies to discuss their specific situations and assess the potential these technologies hold for reducing the tax gap and compliance burden.

First, we focus on one particular use case: VAT in B2B transactions. Exhibit A shows the typical VAT transaction process: Information flows up the left side from the taxpayer across through the e-file exchange to the tax administration agency, which processes it down the right side, allowing an auditor to access the submitted information in an audit package. After risk assessment, payments are made on a periodic basis and flow from bank to bank. During these processes, each side conducts reconciliations to ensure the myriad of information, payments, systems and processes are kept in sync both internally and between the taxpayer and the tax administration agency.

Exhibit A - Current Approach

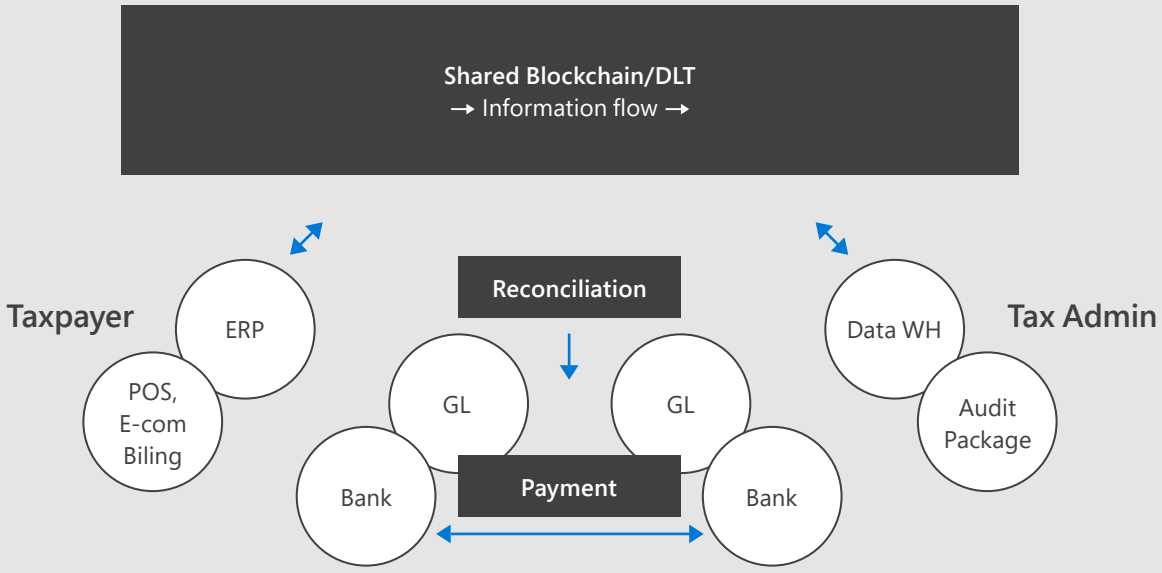


The ability to share a distributed and automatically synchronized database, one in which no super user or system administrator is designed to have privileged access, streamlines several aspects of information exchange. In this design, information flows in real time with the secure identity of the taxpayer managed by the blockchain. Each taxpayer would have access to specific account(s) for which they hold the keys. The tax administration agency would have access to all accounts and would be able to monitor in real time the taxpayer transactions. Benefits might also accrue to other areas of the government in terms of the ability to monitor the economy. This can be

As a first foray into blockchain/DLT, consider a shared secure real-time database rather than periodic file exchange.

thought of as the natural extension to current SAF-T and other near real-time information exchange regimes, moving them from periodic to true real time using a system designed specifically for secure and robust information exchange as illustrated in Exhibit B below:

Exhibit B - Digital Information Approach



Tax compliance and payments

This real-time information exchange described above as applied to taxation is a good starting point for exploring the potential for digital solutions, including blockchain/DLTs. However, issues with reconciliation between information and payment, as well as the risk of the payments not being made, persist. To more adequately address fraud and administrative costs, we can consider integration of blockchain/DLT based payments with this real-time information exchange. Since blockchain/DLT technologies were created with the intention to remove friction from monetary flows, it is natural to consider how a consortium blockchain might be able to also integrate tax payment flows. These private networks are already in use in interbank transfers where the value of the currencies is pegged to existing physical currencies 1:1.[18]

Using the same methodology, we can explore the potential to move the tax payments associated with each discrete bundled piece of tax information at the same time as the flow of information. Simple periodic payments as used today off the blockchain could occur, but the ability of blockchain/DLT to move funds at a low cost allows blockchain designers to consider item-by-item micropayments as a plausible alternative. As an example, each item sold or purchased could result in linked information and payment flows in real time between taxpayers and tax administrators. The payment flows would occur using the blockchain as the

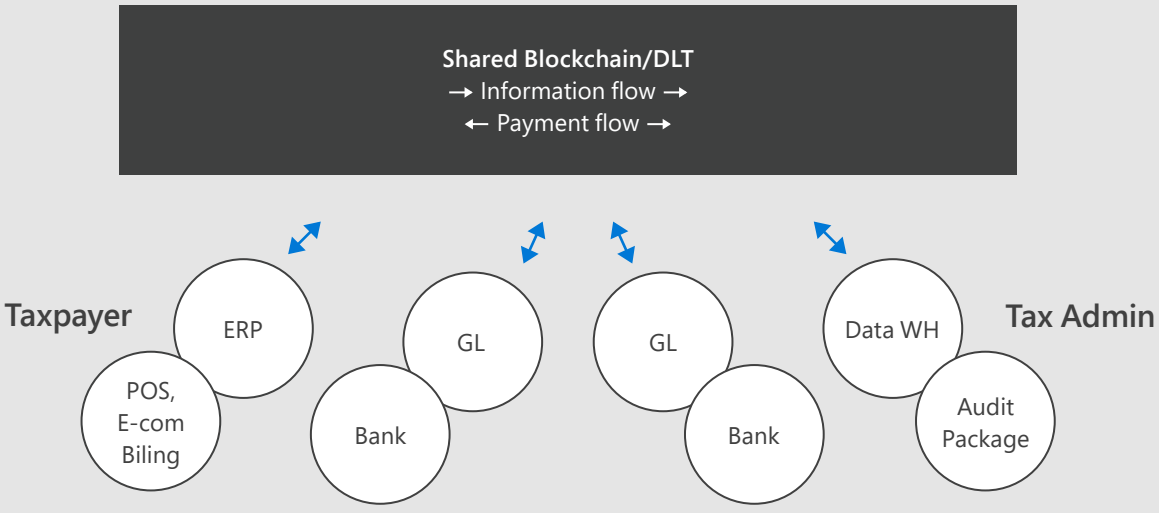
Payments are immediate and other than network costs essentially free in a private blockchain, enabling us to consider real-time, item-by-item detailed payment flows.

settlement network. At any time, excess funds can be moved into the traditional banking system, where they would reside as entries in an account in a traditional database rather than in an account on the blockchain.

In the context of VAT, this combined information and payments flow approach may give tax administrators significantly more control of outgoing VAT payments since they can assess the entity and transaction for risk prior to fully releasing the funds.[19] It might also remove the need for filing tax returns at all since the details are already available and can be analyzed and aggregated as part of the flow.

An example of the type of process envisioned is presented in Exhibit C below:

Exhibit C - Digital Payment Approach



Tax rules

Because the database is shared, the database can store not just taxpayer information and payment transactions, but also tax administrator rules in a transparent and readily accessible manner. Tax rates would be a simple example of the type of information tax administrators could share with taxpayers by publishing this information into the blockchain for pickup and use in off-chain tax calculations (including tax determination systems in use today), and perhaps eventually they could apply the tax rates as rules for on-chain tax calculations in simple cases.

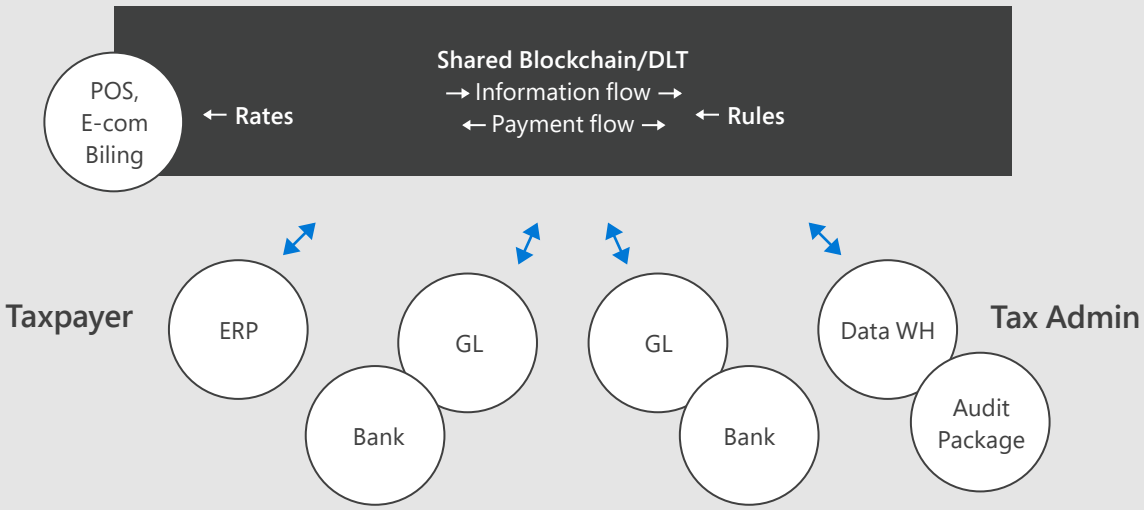
A simple tax example might be a rule where a transaction is rejected unless a valid VAT registration is provided. An advanced example might be a rule where VAT refunds in excess of payments due are held in escrow until the taxpayer's reputation score, per real-time data analytics, exceeds a specified threshold. Another escrow example might be a rule related to invoice matching between buyer and seller in a B2B context. In this case, the input creditable VAT would not be released until the counterparty transaction was logged into the system. As discussed earlier, blockchain technology requires that each transaction comply with rules designed into the system that are transparent and agreed to by all participants. For example, in Bitcoin or Ethereum, the core rules necessary to execute a transaction to move cryptocurrency are 1) the sender has the private key to the account, and 2) there are funds sufficient in the account to make the transfer.[20] Any transaction that adheres to these rules can be executed. The tax example builds upon these two foundational rules and adds a layer of tax specific controls, effectively creating a process of designed compliance.

So, in addition, the blockchain developer would design rules controlling the addition of rate information and payment information to the ledger.

The information and payment flows can be controlled by rules that dictate the conditions and actions to occur in the process flow.

In Exhibit D, the addition of rates and rules into the picture enables the tax administration entity to publish rules in real time for consumption by the tax processing systems, whether POS, e-commerce or traditional billing system. In addition, the information and payment flows can be controlled by rules that work similar to workflow in that they dictate the conditions and actions to occur in the process flow as described in the VAT registration and escrow examples above.

Exhibit D - Digital Rules Approach



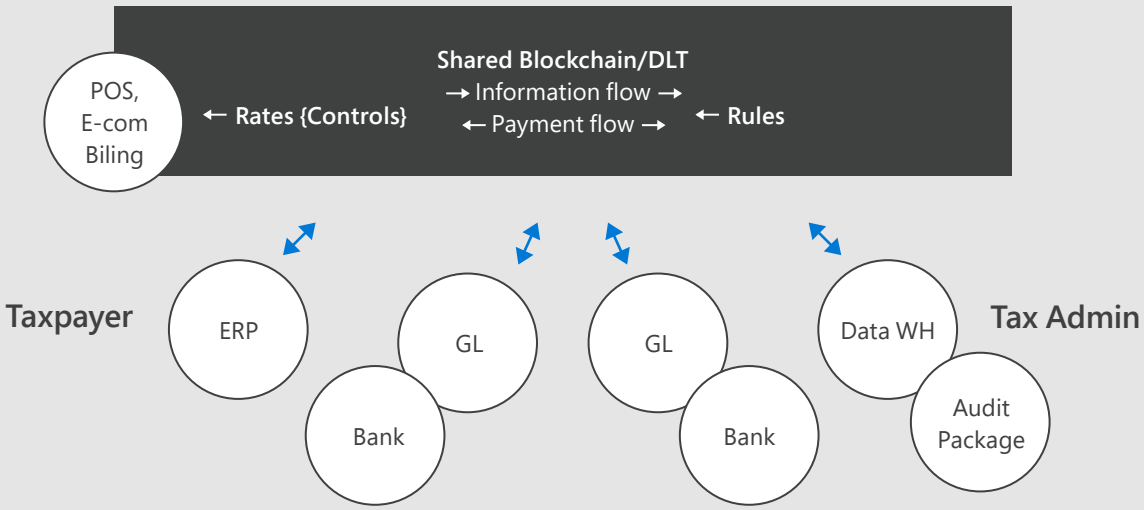
This monitoring goes beyond the business transaction and tax result and into the configurations and setting, which determine the tax result.

Tax verifications

The final step in leveraging blockchain/DLT technology involves its use for monitoring the tax calculation and payment processes.

As illustrated in Exhibit E below, monitoring can be enabled in a transparent manner. Blockchain leverages the ability to capture and monitor the status, or what some call the "state," of a system, and this can be used to send alerts on changes to state to the tax administrators.

Exhibit E - Digital Controls Approach



For example, the current state of a POS system might map the Coca-Cola product to a tax category of soda. If monitored using the blockchain, a change to the setup to remap it to a category of water would be apparent and could be automatically identified as a risk factor. In this manner, a variety of key settings and systems controls could be automatically monitored for changes via the blockchain.

The concept is to wrap existing tax processes into a set of designed compliance verifications, then automate the monitoring of these verifications on an ongoing basis. The first step is to assess the existing processes to ensure they are operating appropriately, the second is to design appropriate system-level verifications, the third is to enable the monitoring of these verifications via technology and the fourth is to design risk assessment and screening processes to manage exceptions.

While blockchain/DLTs are certainly not the complete answer to the challenges facing tax administrations, they represent one plausible means of getting ahead of the disruptive, seismic paradigm shift to full digitalization and corporate systems "talking" directly to tax administration systems. Starting with parallel flows of information in real time and testing incremental benefit at each stage may provide a natural evolutionary path to digital transformation. As the technology matures and key service and technology partners become available, the Public Sector is encouraged to begin the process of assessing these new digital approaches to tax administration.

05.

The digital transformation journey: an approach to implementing blockchain-based tax compliance infrastructure

Digital transformation of tax administrations requires a holistic and strategic approach consisting of six pillars — strategy, legislative framework, operational framework, technological infrastructure, change management and performance measurement. The key components of a successful digital transformation have been discussed in our previous publication "Digital Transformation of Tax Administration."

1. Strategy

Digital transformation, including implementing blockchain, starts with a long-term vision, mission and strategy to tax compliance management. This includes (1) the development of compliance strategies for tax fraud prevention and detection, (2) structural reorganization of tax administrations, (3) choosing the members of the blockchain consortium, and (4) setting key performance indicators (KPIs) tied to the compliance strategy. Performance measurement will enable the tax administration to monitor the progress of objectives on an ongoing basis. Building a sustainable blockchain-based tax infrastructure requires setting realistic deadlines and a proper timeframe for the transformation process.

2. Legislative framework

Sustainable blockchain-based tax infrastructure may require new or amended tax laws and adapted administrative and procedural mechanisms across the current tax system. The first question will be the design of an updated legislative framework to introduce the blockchain technology for tax. For example, in the case of introducing blockchain-based VAT infrastructure, the law should address the cash flow management/ cash liquidity issues for businesses at different stages of development. Second, it is important that not only the legal framework address the implication of the new technology on the current tax system, but also the operational implications. This includes confidentiality, privacy, user terms and conditions, liability in contracts between key stakeholders within the blockchain consortium and training of the tax administration itself. To achieve this, tax experts will need to work with blockchain experts.

3. Operational framework

An operational framework presents a blueprint for the blockchain-based tax infrastructure's core processes, workflows and compliance procedures. This includes the design of a governance model: deciding the blockchain consortium's roles and responsibilities and providing guidelines for operational processes to achieve the strategy. Frameworks need to be flexible and reflect different country contexts; social, political and economic opportunities; and the current system's technological maturity.

4. Change management within the tax administration

Each member of the consortium, including the tax administration, should become comfortable with the technology, so they know how it functions and can rely on it in their daily operations. Fear of "change" and "technology" is one of the main reasons why digital transformation projects fail. Blockchain technology brings particularly significant changes to the current tax system. The involvement of different stakeholders within the consortium will require proper change management, including training and education for the growth and extensions of individual skills, abilities and competencies concerning the new operational blueprint and technologies. It is also important to structure the consortium in such a way that roles and functions are clearly defined and differentiated, lines of communication are untangled and decision-making procedures are transparent and functional.

5. Performance measurement

Sharing successes (and failures) of the new system is an important step toward achieving and maintaining buy-in, credibility and strategic guidance from members of the consortium. Evaluating and publishing the results enhances transparency and accountability and helps to build trust in the system and the tax administration. Effective measurement of the results can be presented in a form of online periodic reports, with dashboards showing how much tax revenue has been collected and providing projections.

The benefits of blockchain adoption for Public Sector

Considering all these aspects the blockchain technology could bring to the tax compliance infrastructure:

01.
Create transparency, remove duplication, and create visibility across all stakeholders

02.
Automate business rules by leveraging Smart Contracts, Accelerated VAT refund and Cancellation of tax audits

03.
Complement the existing system by building a single transparent shared view of the data

04.
Guaranteed VAT collection to the government budget

05.
Less reconciliation will remove complexity and compliance cost

06.
Leverage Blockchain to create trust to reduce the liquidity problem for the companies

06.
Conclusion

The tax administration benefits from greater revenue from reduced fraud and noncompliance, as well as reduced administrative workload. Blockchain may be thought of as a stepwise evolution toward a digitalized future relying on the horizontal monitoring approach to cooperative compliance. The taxpayer agrees to real-time information, payment and monitoring, all integrated into a potentially transparent analytics and risk assessment framework that is rules driven. In exchange, this reduces administrative workload and provides greater business certainty. As noted recently by Hans Christian Holte, Norway's Tax Commissioner and the new chair of the OECD's Forum on Tax Administration:

So, the spotlight is falling onto tax administrations, questioning how they can simultaneously enhance compliance, tackle tax crime, reduce the administrative burden on taxpayers and support economic growth through effective implementation, internal change and engagement with taxpayers.

If we do this properly, I think we could balance both efficiency and simplicity, and also take care of data protection and privacy issues. I think we have to have all those kinds of issues in our heads when we design these solutions, but I think they're a great potential for actually making this happen in a way that both increases compliance and also makes the, you could call it the administrative burden on the business side less, and also actually it makes tax certainty a more real thing.[21]

But we're moving away from that [paper-based reporting schemas] model. It's moving away today, and within the next 10 years I think it will be replaced by what could be quite digital channels of information, going from the accounting systems directly to the tax authorities via digital channels.

Hans Christian Holte
Norway's Tax Commissioner,
Chair of the OECD's Forum on Tax Administration

To the question **"How exactly Blockchain can improve the tax compliance?"** we propose two concrete solutions. Firstly, our vision is to create a **VAT compliance** solution to increase trust, transparency, eliminate fraud and reduce reconciliation effort for society by leveraging the immutable, cryptographically signed and decentralized capabilities of Blockchain. Secondly support governments to build a sustainable, technology-enabled tax infrastructure to benefit from existing, and to facilitate new eco-tourism initiatives in a country (or city), this by investing in blockchain to facilitate **tax payment compliance of eco-tourism revenue**; by doing so a country or local government may become more self-reliant and independent from third-party financial aid (from donor countries, banks or businesses) and work toward achievement of the UN Sustainable Development Goals (UN SDGs) 16 & 17.

We invite you to consult the second part of our whitepaper **"Two practical cases of Blockchain for Tax compliance"** that details the two use cases and aims to provide guidance on the journey to adoption.

Appendix

The blockchain ecosystem

Blockchain is not a one-size-fits-all solution. Different enterprises require different ledgers for different purposes.

As a response to different needs, a variety of blockchain designs exists today and new designs are emerging regularly. The design of your application requires analysis and consultation with trusted technical advisors.[21]

Confidential consortium blockchain framework

As enterprises look to apply blockchain technology to meet their business needs, they've come to realize that many existing blockchain protocols fail to meet key enterprise requirements such as performance, confidentiality, governance and required processing power. In order to help address these issues, Microsoft introduced the Confidential Consortium Blockchain Framework, an open-source system that enables high-scale, confidential blockchain networks that meet key enterprise requirements — providing a means to accelerate production and enterprise adoption of blockchain technology.

Microsoft's Confidential Consortium Blockchain Framework represents a breakthrough in achieving highly scalable, confidential, permissioned Ethereum or other blockchain networks that will be an important construct in the emerging world of variously interconnected blockchain systems.

Joseph Lubin
Founder of ConsenSys

The Confidential Consortium Blockchain Framework is designed specifically for confidential consortiums, where nodes and actors are explicitly declared and controlled. Based on these requirements, the framework presents an alternative approach to distributed ledger deployments, giving enterprises greater scalability, distributed governance and enhanced confidentiality, while working to maintain the inherent security and immutability blockchain users expect.

Azure blockchain workbench

The implementation of the blockchain application is only a small fraction of the technical work. Things like the formation and configuration of the consortium, integration with the identity providers, interoperation with external business applications messages and events, integration with off-chain data repositories, user screen building, and reporting are some of the tasks to be accomplished in order to have a production-ready blockchain system.

Microsoft acknowledges the challenges that businesses have in the adoption of blockchain solutions and offers Azure Blockchain Workbench. Azure Blockchain Workbench is a collection of Azure services and capabilities designed to help enterprises create and deploy a new class of applications for sharing business processes and data with multiple, semi-trusted organizations. Currently customers can deploy these services into their subscriptions and integrate them with blockchains available on the Azure Marketplace.

With Azure Blockchain Workbench, the heavy lifting is generally done for them, so enterprises can focus less on scaffolding and more on logic and smart contracts.

Azure Blockchain Workbench simplifies blockchain application development by providing a solution using several Azure components. Azure Blockchain Workbench can be deployed using a solution template in the Azure Marketplace. The template allows users to pick the modules and components to deploy with Azure Blockchain Workbench, such as blockchain stack, type of client application and support for IoT integration. Once deployed, Azure Blockchain Workbench provides access to a web app, iOS app and Android app.

Using Azure Blockchain Workbench, a consortium can federate their Enterprise identities using Azure Active Directory (Azure AD). Workbench generates new user accounts for on-chain identities with the enterprise identities stored in Azure AD. The identity mapping facilitates authenticated login to client APIs and applications and uses the authentication policies of organizations. Workbench also provides the ability to associate enterprise identities to specific roles within a given smart contract. In addition, Azure Blockchain Workbench also provides a mechanism to identify the actions those roles can take and at what time.

After Azure Blockchain Workbench is deployed, users interact with Azure Blockchain Workbench via the client applications, REST-based client API or Messaging API. In all cases, interactions must be authenticated, either via Azure Active Directory (Azure AD) or device-specific credentials.

Users federate their identities to a consortium Azure AD by sending an email invitation to participants at their email address. When logging in, these users are authenticated using the name, password and policies and two-factor authentication of their organization.

Azure AD is used to manage all users who have access to Azure Blockchain Workbench. Each device connecting to a smart contract is also associated with Azure AD.

Azure AD is also used to assign users to a special administrator group. Users associated with the administrator group gain administrator rights/actions within Azure Blockchain Workbench, such as deploying contracts and giving permissions to a user to access a contract. Users outside this group do not have access to administrator actions.

Azure Blockchain Workbench provides automatically generated client applications for web and mobile (iOS, Android), which may be used to validate, test and view blockchain applications.

The application interface is dynamically generated based on smart contract metadata and can accommodate many use cases. The client applications deliver a user-facing front end to the complete blockchain applications generated by Azure Blockchain Workbench. Client applications authenticate users via Azure Active Directory (Azure AD) and then present a user experience tailored to the business context of the smart contract. The user experience enables the creation of new smart contract instances by authorized individuals and then presents the ability to execute certain types of transactions at appropriate points in the business process that the smart contract represents.

Azure Blockchain Workbench includes a REST-based gateway service API. When writing to a blockchain, the API generates and delivers messages to an event broker. When data is requested by the API, queries are sent to the off-chain SQL database. The SQL database contains a replica of on-chain data and metadata that provides context and configuration information for supported smart contracts. Queries return the required data from the off-chain replica in a format informed by the metadata for the contract.

The Azure SQL database attached to Azure Blockchain Workbench stores contract definitions, configuration metadata and an SQL-accessible replica of data stored in the blockchain. This data can easily be queried, visualized or analyzed by directly accessing the database. Developers and other users can use the database for reporting, analytics or other data-centric integrations. For example, users can visualize transaction data using Power BI.

This off-chain storage provides the ability for enterprise organizations to query data in SQL rather than in a blockchain ledger. Also, by standardizing on a standard schema that's agnostic of blockchain technology stacks, the off-chain storage enables the reuse of reports and other artifacts across projects, scenarios and organizations.

About the authors

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Kuralay is a core team member of PwC's Tax Strategy & Operations practice. She is focused on design and implementation of sustainable tax compliance strategies for governments, tax administrations, intra-governmental organizations, businesses and other organizations. This also includes support on digital transformation agenda, innovative audit strategies, co-operative compliance modelling, capacity building and performance measurement. Prior to joining PwC, Kuralay specialized in international aspects of corporate taxation of MNEs and conducted several research-works in the field of tax policy. She holds an LL.M. Degree in International Tax Law from Vienna University of Economics and Business.

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Eelco leads PwC's Tax Strategy & Operations practice and has nearly 30 years of experience. Before joining PwC in 2007, he worked for various multinationals as head of tax, treasury, risk management and corporate finance. He supports businesses, governments, tax administrations, intra-governmental organizations and NGOs in their endeavors to design and implement sustainable tax compliance strategies. As part of this process, he advises on and implements solid foundations for ameliorating tax compliance infrastructures by building performance measurement systems and innovative audit strategies. He is a lecturer at various European universities, and Chairman of the Tax Policy Group of Accountancy Europe. Eelco has published more than 40 articles on tax governance and is chief editor of Tax Assurance Magazine.

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Çiğdem holds a Bachelor of Science degree in Computer Engineering, a Master of Science in Software Engineering and Master's degree in Business Administration.

About PwC

At PwC, our purpose is to build trust in society and solve important problems. It is this focus which informs the services we provide and the decisions we make. Demonstrating genuine leadership is more important to us than size or short-term revenue growth. To achieve our aim to be recognized as "the leading professional services firm," we must be innovative, responsible and attract outstanding people. Our strategy is therefore built around five priorities: 1. be technology enabled; 2. deliver exceptional value to our clients; 3. empower our people; 4. lead by example; 5. invest in sustainable growth. Attracting the right talent continues to be paramount, and as a progressive employer, we will continue to develop a diverse and agile workforce.

About Vertex

Vertex is the leading provider of corporate tax software and services for companies of all sizes. Our cloud and on-premise solutions enable compliance for every major line of tax, including sales and use, income, value-added, and payroll. Our solutions continually raise the bar on how to simplify tax calculations and reporting while complying with ever-changing tax rates and rules.

About Microsoft

Microsoft is the leading platform and productivity company for the mobile-first, cloud-first world, and its mission is to empower every person and every organization on the planet to achieve more. Our vision is to help government organizations do more to promote citizen well-being, influence positive societal change, and enhance the services they deliver.

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6 https://plato.stanford.edu/entries/sovereignty/#3

7 For additional background on this technology, the following resource is recommended: https://www.coursera.org/learn/cryptographic-hash-integrity-protection

8 https://www.canada.ca/en/financial-consumer-agency/services/payment/digital-currency.html

9 https://www.gov.bm/articles/cryptocurrency-initiative

10 Croman, Kyle; Eyal, Ittay (2016) 10.1007/978-3-662-53357-4_8

11 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/251481/Government-Security-Classifications-Supplier-Briefing-Oct-2013.pdf

12 In distributed systems there is a trade-off among decentralization, speed and information security. To increase one, you must decrease another. Recent innovations focus on linking multiple blockchains together to gain speed via parallelization without reducing decentralization or information security.

13 http://www.oecd.org/tax/administration/tax-compliance-by-design-9789264223219-en.htm

14 https://illinoisblockchain.tech/

15 These "Keys" are unique strings of text stored in a file on a computer.

16 https://www.nasdaq.com/article/how-blockchaintechnology-can-securecontactless-payments-cm950732

17 https://e-estonia.com/tag/blockchain/

18 https://www.coindesk.com/jpmorgan-launches-interbank-payments-platform-quorum-blockchain

19 For example, tax administrators could use a blockchain/DLT to escrow taxpayer funds until risk assessment criteria have been validated. This would enable the taxpayer to see but not withdraw funds during the assessment period. Taxpayers with existing banking relationship could potentially obtain loans with the escrow funds as collateral, alleviating cash flow issues and placing banks in the role of credit assessor.

20 https://github.com/ethereum/wiki/wiki/White-Paper

21 https://www.ey.com/Publication/vwLUAssets/ey-a-discussion-with-the-hans-christian-holte/$FILE/ey-a-discussion-with-the-hans-christian-holte-issue-22-june-2018.pdf

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