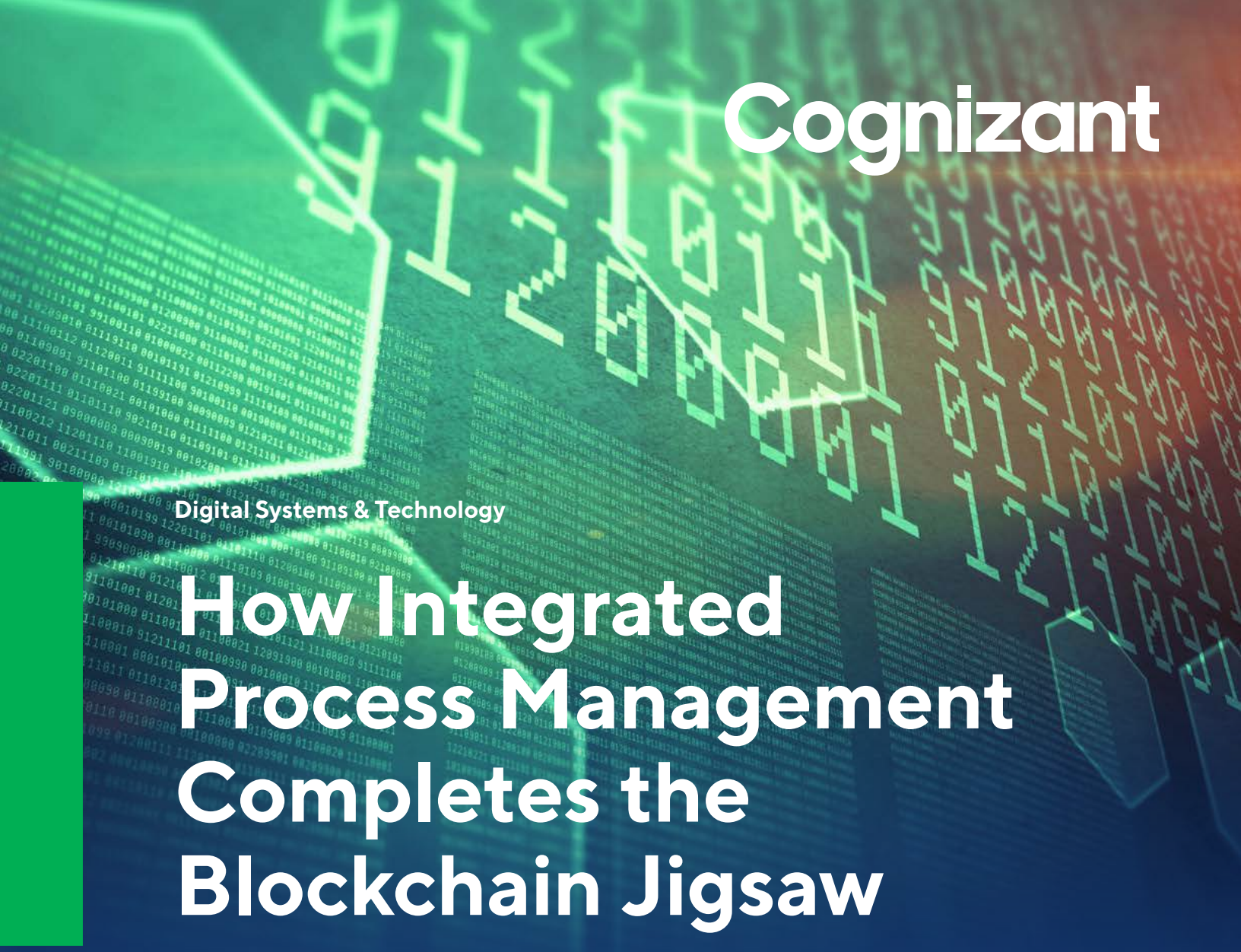

Cognizant

Digital Systems & Technology

How Integrated Process Management Completes the Blockchain Jigsaw

Distributed ledger technology promises to make digital transactions safer for all parties, but only if organizations take a holistic view by applying traditional business orchestration and integrated process management to tightly connect legacy systems of record with emerging blockchain networks, promoting trust and true collaboration across their value chains.

April 2018

Executive Summary

We are living in an age when digital business shifts are reshaping the way technology, regulatory policies, governance and market adaptations combine to disrupt our socio-economic and cultural well-being. Blockchain technology represents one such disruption. As a powerful method of securing digital transactions through a distributed cryptography framework, blockchain has emerged as the new "trust protocol."

During the last decade, blockchain technology developed as a core component for Bitcoin, the leading cryptocurrency. Since then, several blockchains have emerged as public ledgers for specific types of transactions. For example, companies like IBM and Samsung[1] are using blockchain technology for a decentralized network of Internet of Things (IoT) devices, operating like a public ledger to enable them to communicate with each other directly to update software, manage bugs and monitor energy usage. The technology is now seen as having the potential to solve the double-spending problem that has plagued many industries, and to do so without the need for a trusted authority or central server. Blockchain's tamper-proof design is the key to its security.

Every node in the decentralized blockchain network contains a copy of a transactional record: Data changed in one node needs to be authenticated by peers' approvals once it is replicated across the network. The blocks, formed through a continuous growing list of records as the basic foundation, are linked and secured using strong public key infrastructure cryptography. These blocks are connected to each other with a hash pointer (cryptographic hash function) that ensures transactions are tamper-free.

In our view, blockchain will become imperative for any organization seeking to survive and thrive in the unfolding digital economy. This white paper details blockchain's inner workings and offers insight into how modern enterprises might leverage integration and process management as strategic enablers for gaining competitive advantage via blockchain-powered networks.

As a powerful method of securing digital transactions through a distributed cryptography framework, blockchain has emerged as the new "trust protocol."

Blockchain: what, how & why

Conceptually, blockchain is tantalizingly simple. It can be easily explained as a type of database for recording and confirming transactions. Each transaction is verified, recorded and combined with other transactions to produce a new block in the ledger that is then copied to peer nodes in the participating network, thus creating a distributed ledger of sorts. These transactions can range from moving data to transferring money, and even relating confidential personal information, etc.

The scope of blockchain transactions is not limited to Bitcoin, distributed ledger files, transaction databases or tamper-proof blocks; it has applications and benefits across a host of functionalities, which we will explore. (For more on blockchain's wide applicability, see our primary research series.)

As a distributed database technology for recording and confirming transactions, blockchain groups related transactions to form a block, which is then shared to all other peers in the network to verify and update their respective copy of the ledger. Holistic solution implementation requirements include: a UI, cryptographic key management, sometimes an IoT component, legacy systems integration (to connect with enterprise systems of record), distributed file storage and distributed database.

Typically, blockchain networks are built on a modular architecture that separates transaction processing into the following three phases:

- Distributed logic for processing and agreement (e.g., smart contracts).
- Transaction ordering.
- Transaction validation and commitment.

These phases empower a blockchain network's ability to create and secure blocks. To function, a blockchain needs to perform the following tasks: collect and order data into blocks; link the blocks together securely through cryptography; share these blocks with peers among the network; validate and authenticate the blocks; and maintain consensus among the parties in the network (see Figure 1, page 5).

Upon completion of a blockchain transaction, the information is recorded and shared with all peer systems on the participating network. This record is then combined with other transactions in the form of a block, with each transaction (or block) time-stamped, similar to the way traditional database software works. The time-stamping effectively arranges the information in a sequential order, thereby avoiding duplication or mismatch errors. These immutable data blocks, along with time stamps, are appended to the ledger of each participant. All members of the blockchain network can view the same transaction history in the

Anatomy of a blockchain network

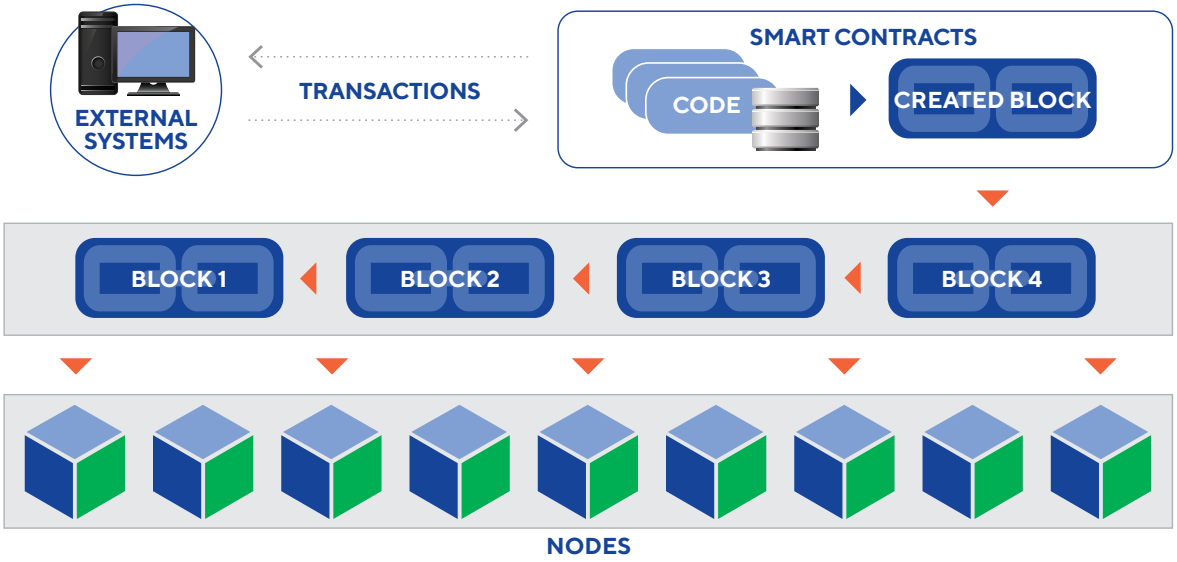

Figure 1

same order. The above description may be confused with an application program interface (API) that gets triggered by an external transaction, thereby further executing a set of business rules. This business rule set execution could correlate events/data and/or business logic to eventually create records in a database. So, how are these different from the blockchain world? While there are a number of differences, here are the most important ones:

- **No more single authority for authorization:** Participating parties can avoid centralized intermediaries by using a peer-to-peer business network.
- **Enhanced security:** Participants can reduce fraud while strengthening regulatory compliance. Countries in the APAC region including China, South Korea and India have adopted stringent regulations to curb the use of cryptocurrencies powered by blockchain technology, while at the same time they have advocated for the use of blockchain technology in other areas of economic activity such as public distribution systems. Blockchain ensures that data will be secured via cryptographically linked blocks that prevent anyone from altering or deleting records without detection.
- **High availability:** Blockchain's lack of a central repository or single point of failure — i.e., the fact that its data is distributed across multiple ledgers — makes it fail-safe. Every node in a decentralized system has a copy of the ledger. Data quality is maintained by massive database replication and computational trust.

The hash function

Once the block is complete and time-stamped, it is sent across the participating network, appending and linking transactions to the chain of other blocks. The blockchain is secured by a "hash" function. The hash function is a cryptographic algorithm, which makes it impossible to break the link between the blocks in the blockchain. The hash function uses the information in each block to create a string of characters unique to each block.

The hash from each block is then added to the data in the next block. This means that for every block transmitted, part of its own information is embedded into the unique set of characters generated in the resultant new hash. This process is replicated, including time-stamps, for all blocks throughout the chain. Thus, any tampering with a block will cause the next block to mismatch, since the embedded hash won't align across the chain. This mismatch will then continue across all the subsequent blocks, which will indicate tampering. With all peers in the participating network possessing a copy of the blockchain, any tampering can easily be detected. If the hashes match up across the chain, the participants can trust their records.

Smart contracts

A key component of the blockchain ecosystem is the smart contract, which is a set of detailed and often complex rules that describe an operation in a step-by-step manner. Smart contracts manage the business rules and processes that execute a transaction. The smart contract can be executed to act on information passed or extracted from peripheral systems in adherence to the rules embedded in the contract. Thus, a smart contract can automate business processes in a trusted way, by allowing stakeholders to process and validate contractual rules as a group.

Given the shared, decentralized nature of blockchain technology, risks and benefits are distributed. Compare this to traditional business orchestration and process management software development, where a single stakeholder bears the investment and risk for a multi-stakeholder (customer/partner/enterprise) value chain. Blockchain technology represents a more egalitarian approach, thereby promoting collaboration (see Figure 2).

Blockchain's collaborative quotient

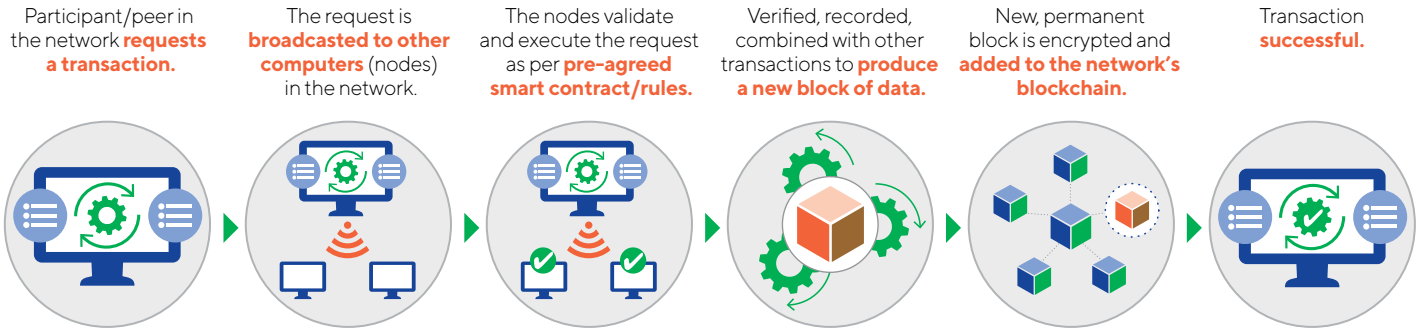

Figure 2

With all peers in the participating network possessing a copy of the blockchain, any tampering can easily be detected. If the hashes match up across the chain, the participants can trust their records.

Blockchain technology's reach and transparency are vast, and offer participating network peers enormous benefits. Perhaps most critical, blockchain helps bridge the trust deficit many parties experience when transacting digitally. The shared, open and incorruptible ledger of record spanning multiple markets and business functions will help to prevent fraudulent activities. Blockchain technology has huge potential to strengthen compliance functions such as know your customer (KYC) and anti-money laundering (AML) activities for banks, sustainable sourcing practices for supply chains, and quality reporting for Centers for Medicare & Medicaid Services (CMS) for healthcare organizations.

Blockchain's evolution

Since its conception, blockchain has evolved from a powering mechanism of the Bitcoin cryptocurrency, to a technology that is poised to streamline the entire enterprise landscape. Its ongoing development can be broken down into four stages:

- **Blockchain V 1.0:** Applications in cryptocurrencies, particularly Bitcoin, through implementation of distributed ledger technology.
- **Blockchain V 2.0:** Smart contracts, to facilitate, verify and execute transactions. The emergence of the Ethereum ecosystem is one such example, as well as the evolution of decentralized applications, which use decentralized storage and decentralized communications protocols.
- **Blockchain V 3.0:** Development and maturation of permissioned blockchains with throughput and confidentiality innovations suitable for the enterprise.
- **Blockchain V 4.0:** The next step in blockchain's evolution is the industry-wide deployment of value chains including the integration of enterprise systems and encompassing boundary-less process automation; these developments should eventually increase transparency and trust among enterprises, employees and customers.

Blockchain technology incorporates two distinct capabilities that can be leveraged to help orchestrate business processes across organizations:

- **Trust:** Typically, each line of business within an enterprise builds its processes, but a transaction across such processes requires some level of trust. While most monitoring and recording of sequences is managed though logs and security in legacy systems, blockchain technology would do this through smart contracts among participating nodes.
- **Distribution:** With processes distributed across enterprises, a centralized governance or an administration system may not be possible. Blockchain technology solves this issue by providing decentralized storage and decentralized communication, thus enabling trusted orchestration governed in a distributed manner.

Integration and business process management streamline business processes within an organization where participants normally trust each other. In contrast, blockchain technology enables the execution of business processes across multiple organizations and untrusted participants, delivering blockchain adherents to the fourth evolutionary stage, V 4.0.

Blockchain 4.0: enterprise-wide systems

Integrating blockchain with enterprise systems can help organizations to better manage the lifecycle of digital transactions among various business entities, customers, systems and technologies. Therefore, adopting blockchain offerings (features/capabilities) is the prudent way forward. The middleware/digital integration space will also evolve, and develop smart contracts containing the requisite business logic. For example, stock and payment blockchains can potentially interact during partner/B2B transactions.

Blockchain is an evolving technology that proposes to increase trust across transactional partners. Use cases span business to business (B2B), electronic data interface (EDI), applications, etc. Blockchain technology has the ability to provide a standard framework and database that will offer a single view of transactions. It can replace B2B integration by potentially replacing B2B/EDI technologies for classic trading/e-commerce.

As noted above, blockchain technology is not a stand-alone system; it requires feeder systems of record (such as ERP, CRM or other legacy systems) to integrate with, in order to expand the automation possibilities offered via smart contracts.

The following use cases are also relevant:

- **Business process management with smart contracts:** Using BPM as peripheral services to automate the management of transactions or provide approvals as necessary.
- **Event correlation:** Using complex event processing (CEP) to manage event outcomes when transactions are confirmed as blocks.

Figure 3 depicts why integration and process management services are essential to blockchain deployments.

Service integration: a reference architecture

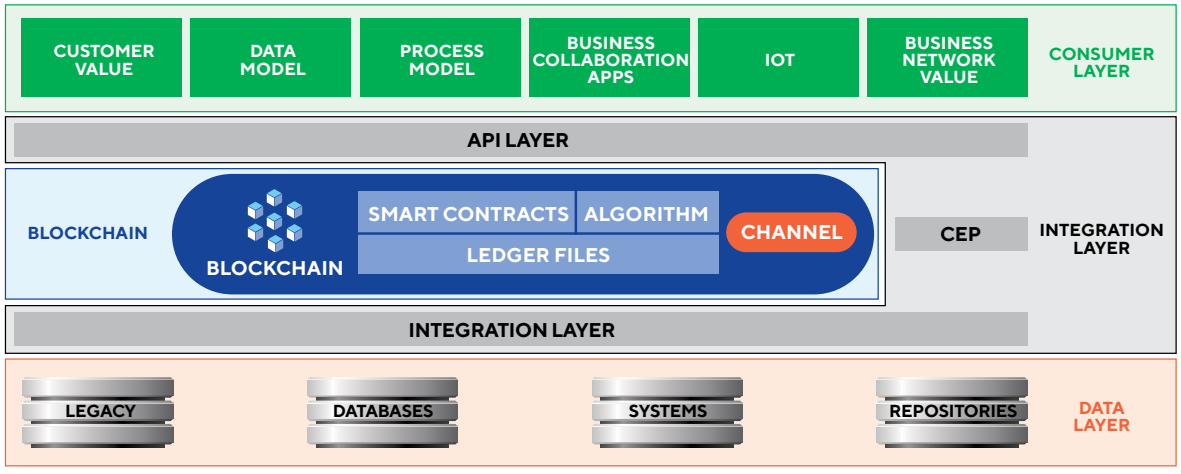

Figure 3

- **Data layer:** This comprises all the systems necessary to gather information, typically accessed when smart contracts are triggered by external transactions.
- **Blockchain:** This is the crux of the implementation, comprising distributed ledgers, smart contracts channels, consensus logic, etc.
- **Consumer layer:** Applications such as BPM, B2Bs, IoT, etc. at the top of an implementation would either consume services exposed via APIs or trigger services to enable a transaction such as a business contract between two parties governed by consensus logic.
- **Integration layer:** This can facilitate integration across back-end systems, and orchestration in this layer of back-end and blockchain systems can help expose APIs that might later be monetized.

Blockchain can solve numerous problems — some existent, some emergent. The following examples explain how integration can help enterprises realize the true power of blockchain. The first example discusses integration itself, the second example concentrates on B2B/EDI, the third one on BPM and the final one on complex event processing (CEP).

The pursuit of integration

Recent studies in the airline industry show that thousands of passengers do not apply for claims owed them for delayed or cancelled flights. The situation could change drastically if these claims processes were automated through blockchain. Passenger flight information would be maintained as part of a blockchain, along with a smart flight-cancellation insurance contract with policy conditions that would be applied in the event.

For instance, a delayed flight could be managed as a public record, and any such event could trigger a smart contract, and a payout could be made automatically. In this scenario, integration, CEP, BPM and API would combine to enable a successful resolution for passenger and airline carrier. This use case would entail:

- Integration of blockchain with back-end systems to retrieve passenger information: insurance, etc.
- Integration with external APIs (connectivity with banks' electronic payment systems) for making refunds to passengers.
- Integration with communication channels to notify passengers about refunds.
- Exposing channels to external applications (i.e., airlines) to create records in case of flight delays or cancellations.
- Triggering CEP rules (if necessary) via an event created to generate system alerts for possible delays across the board. Delays or cancellations may occur for multiple reasons.
- Having a BPM process in place as an overlay in case of payout authorization, if necessary.

This improves existing processes in the following ways:

- It eliminatres manual processes other than the initial claim submission, thus reducing friction, speeding resolution and cutting costs. Transaction errors and missing information are also reduced.

Blockchain technology has the potential to change the environment in which interorganizational processes are able to operate. Blockchains offer a way to execute such processes in a trustworthy manner.

- It creates an immutable audit trail that allows anyone with the correct privileges to view the claim's lifecycle.
- The process also secures data elements, because every transaction is encrypted with the blockchain member's key. Thus, a cybercriminal would need access to each blockchain member's key to access all the transaction data.

Partner management

Today, most organizations have embraced B2B platforms, but in most cases end-to-end visibility for all the parties may not be available, unless implementation is paid for. And even then, a complete real-time view may not be delivered. Blockchain will remediate this and (if required) can eliminate the need for a B2B platform to reveal the exchange of records validated by smart contracts. It can also deliver a complete view of the order status to all parties involved to avoid disputes among them.

Blockchain differs from traditional B2B systems in two key ways:

- Distributed ledger delivers a secure, auditable record of events for shared visibility of supply chain information flows across all peers/parties in real time.
- Events/B2B documents can be recorded on a blockchain as blocks representing the status of an order, out of the box.

Business process management

BPM is concerned with the design, execution, monitoring and improvement of business processes. Systems that support the enactment and execution of processes are used by companies to streamline and automate processes, which are typically confined to enterprises. However, common business processes that span multiple enterprises have not been adopted widely due to lack of trust and to challenges in joint design. Blockchain technology has the potential to change the environment in which interorganizational processes are able to operate. Blockchains offer a way to execute such processes in a trustworthy manner.

Financial institutions spend huge amounts to keep up with KYC and customer due-diligence regulations. These solutions are typically implemented on BPM platforms. The existing KYC process consists of submitting a set of identification documents each time an individual or corporate customer starts a new relationship with a bank.

KYC is typically conducted by individual banks, requiring customers to provide the same information to different institutions. A consortium of financial institutions can use a KYC business process application platform to implement generic processes that provide high-level business functionality. Such functionality would integrate blockchain technology to collect, validate and share more accurate customer information. This vastly reduces the duplication of information and manual checks for both banks and customers, while enhancing the quality of the customer information that is stored.

Blockchain adoption will impact existing business processes. BPM systems provide convenient abstractions for rapid development of process-oriented applications, by taking a business process model as a starting-point representation; for example, in business process model and notation (BPMN).

For example, Caterpillar[2] is an open-source business process management system (BPMS) that runs on top of the Ethereum blockchain. The specificity of Caterpillar is that the state of each process instance is maintained on the Ethereum blockchain, and the workflow routing is performed by smart contracts generated by a BPMN-to-Solidity compiler.

Smart contracts that can be trusted to enforce a process execution can be generated from BPMN process models. In addition, blockchain could also be leveraged in the BRM space when implementing a BPM solution. The rules could be implemented as smart contracts, which would add validation, flexibility and agility.

BPM-based low-code development capabilities allow blockchain application developers to abstract the complexity of blockchain and model it visually, so that it's easier to quickly integrate applications with any public or private blockchain technology. By using BPM instead of working directly with blockchain, organizations can reduce the effort, time, cost and risk associated with building production-ready blockchain-based applications.

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Complex event processing

With CEP, event handlers need to be configured to listen for changes in the blockchain, or the connected endpoints, and then correlate and invoke appropriate CEP rules to either derive an action or alert. For example, in the airline claims example, event handlers may receive a message based on changes in the ledger files managing flight status to initiate payouts to consumers who have opted for travel delay insurance.

Event handlers can then work along with configured contracts to draw inferences on payout rules. Based on outcomes of the processing, they can either trigger other events or integrate with peripheral systems, databases etc., and even microservices within the enterprise architecture to drive necessary actions.

Challenges and considerations

Despite its great promise, the adoption of blockchain technology is still in its early stages. By considering the following factors, organizations can speed their embrace and reap greater business value from blockchain technology:

- **Awareness:**
  - Individuals and most businesses are generally unaware of blockchain's vast potential. Organizations must generate awareness inside key functional areas of their organizations and industry value chain to bring attention to its potential benefits.
  - According to our primary research report "Building Blockchain One Block at a Time,"[3] 53% of the respondents s believe making blockchain understandable to key decision-makers is among the key internal organizational challenges for its adoption.

- **Maturity:**
  - Systems integration standards remain a work in progress for blockchain. These need to be established and enforced. In fact, 58% of respondents in our study said the lack of standards is one of the key external obstacles to blockchain adoption.
  - With the increased adoption of blockchain-based systems, specialized skills around the
  - technologies are required (e.g., chain-code developers, experienced hands-on Go language coders, etc.).
  - According to our research, 41% of respondents see "reengineering business processes" as one of the key internal organizational challenges to blockchain adoption.

- **Adoption:**
  - **Cultural:** Moving from a centrally administered system to decentralized systems will create change management challenges. This may occur for a variety of reasons, including the fact that the knowledge is typically limited to developers and the user community. According to our study, 6% of the respondents see culture and change management as one of the key internal organizational challenges to blockchain adoption. Our study also noted that working with partners/ecosystem members was seen as an external challenge to blockchain adoption by 56% of respondents.

Harnessing the power of blockchain technology will require businesses to understand its impact on core business processes, as well as the systems integration challenges present both within the organization's own walls and with external parties.

- **Talent:** Blockchain adoption is also dependent on available talent. Our study found that 40% of the respondents see procuring talent and expertise as one of the key internal organizational challenges to blockchain adoption.
- **Regulatory:** Regulations around blockchain technology are limited. However, recognition of crypto keys as valid as e-signatures, and recognition of digital assets as legally valid could help unleash more effective regulations. This will be a key for the adoption and implementation of blockchain technology. Our study found that 38% of the respondents see ensuring data security as one of the key internal organizational challenges to blockchain adoption. Legal and regulatory issues were also cited by 56% respondents as a significant obstacle to blockchain adoption.

Looking ahead

Enterprise blockchain holds exciting promise for many industry applications. Blockchain technology is set to redefine the future of digital enterprises, bringing new levels of efficiency, security and trust to widespread applications, from stock trading and personal banking, to e-commerce and supply chain management. With increased adoption of blockchain strategies and subsequent technological maturity, organizations will become increasingly aware of how business transactions occur in real time.

Harnessing the power of blockchain technology will require businesses to understand its impact on core business processes, as well as the systems integration challenges present both within the organization's own walls and with external parties.

In an age where trust deficits among governments, businesses and consumers are widening, blockchain technology offers a remedy by delivering benefits such as curbing fraud by securing data, providing insights to transaction records and substantially reducing the cost of transactions by eliminating intermediaries. Once organizations experience the benefits of blockchain technology, there will be no turning back.

Endnotes

1 www.coindesk.com/ibm-reveals-proof-concept-blockchain-powered-internet-things/.

2 http://ceur-ws.org/Vol-1920/BPM_2017_paper_199.pdf.

3 www.cognizant.com/whitepapers/financial-services-building-blockchain-one-block-at-a-time-codex2742.pdf.

Resources

- https://bitcoin.org/bitcoin.pdf.
- www.hyperledger.org.
- https://medium.com/.
- Don Tapscott & Alex Tapscott, Blockchain Revolution: How the Technology Behind Bitcoin Is Changing Money, Business, and the World, Penguin Random House, June 2016, http://blockchain-revolution.com/the-book/.

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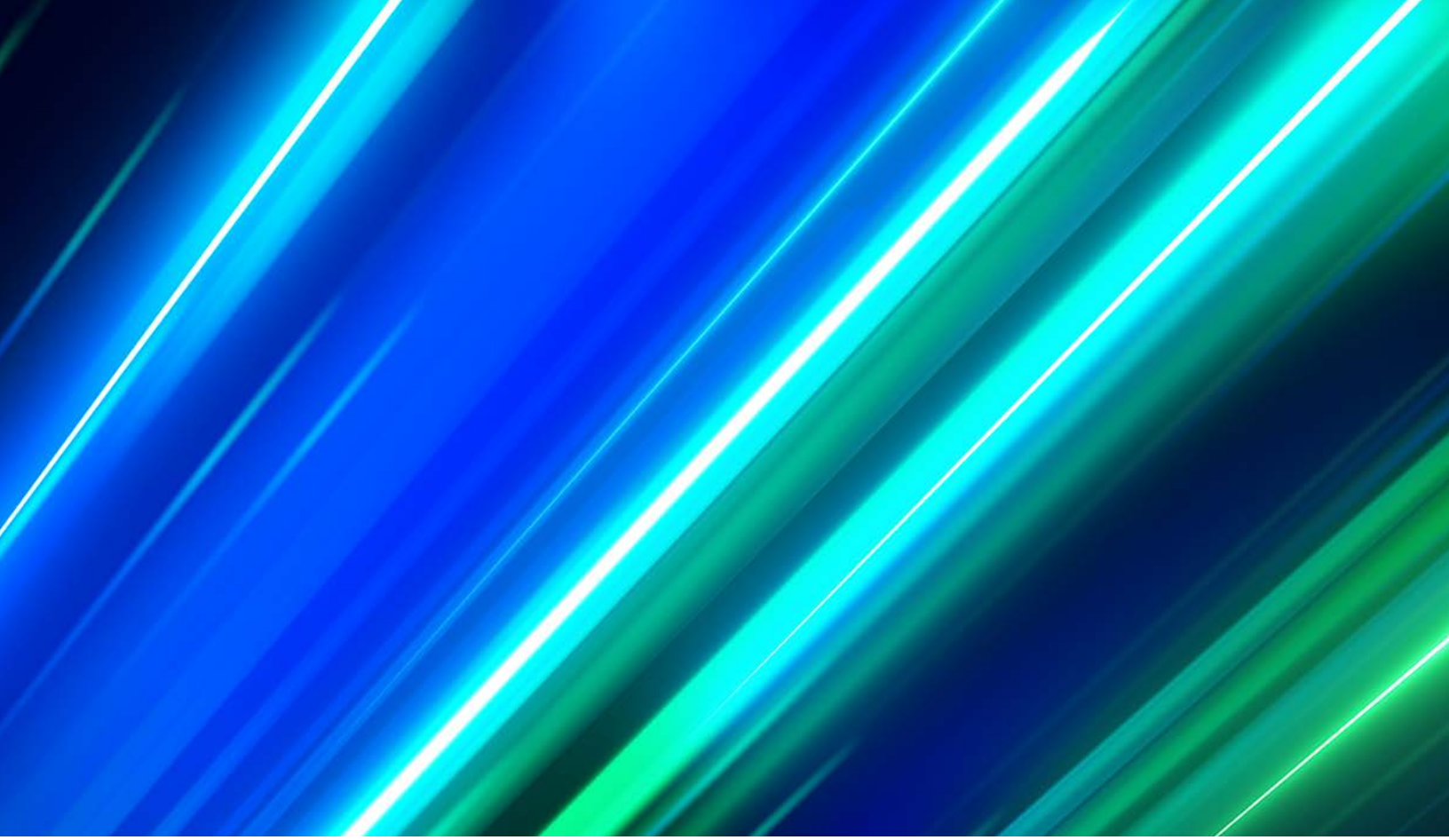

About Integrated Process Management

Integrated Process Management (IPM) is one of Cognizant's foremost technology practices, and also the world's leading integration middleware and process management group. For more than a decade, Cognizant's IPM Practice has been delivering large-scale, complex, cutting-edge, customized technology and business solutions to leading global corporations for their complex integration and process automation needs.

We use the most appropriate tools and techniques, covering Connected Digital Enterprise (enterprise and partner Integration, iPaaS, hybrid cloud integration, deep integration, API management, microservices), Digital Process Management (optimized BPMS, dynamic case management, intelligent and robotic process automation) and Digital Enablement Platform (IOT & device integration, blockchain integration, intelligent automation platform, low code application platform). These activities ensure positive business outcomes for our customers.

Our service offerings are equipped with next-generation solutions, frameworks and methodologies, powered by industry best-practices and extensive knowledge repositories. This not only improves service and but also enhances value during the entire digital transformation journey.

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