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Digital Transformation in Enterprise Architecture: How is blockchain useful?

A client's journey to streamline and optimize its operating and development models through the use of Distributed Ledger Technology (DLT), crowdsourcing, and UI customization



Introduction & background

One of several reasons why people are focusing so much attention on blockchain is because of its perceived capability to uniquely provide all participants in a given value chain a complete, common, consistent, controlled, selectively permissioned, and (especially) ‘trusted’ view of all data related to said value chain’s entire history and current state. As such, many companies, industries, and various consortia are running extensive experiments with blockchain-related technology.

To get past the hype surrounding blockchain and help understand how Xerox might be able to

effectively employ its underlying components, Xerox Digital Experience (XDX; formerly known as Xerox Information Management) commissioned its Solution Acceleration and Innovation Team (SAI) to run a blockchain-based Proof of Concept (POC). Xerox partnered with Wipro, a company with both significant blockchain experience and a uniquely large crowdsourcing community (called “Topcoder”), to implement the POC. Wipro used an early version of SAP Leonardo’s

Blockchain-as-a-Service (BaaS) to implement the POC’s blockchain capabilities as encoded on the Hyperledger Fabric open source protocol. From a full stack perspective, Mongo DB, NodeJS, and ReactJS all played a role. Figure 1 shows the high-level solution architecture:

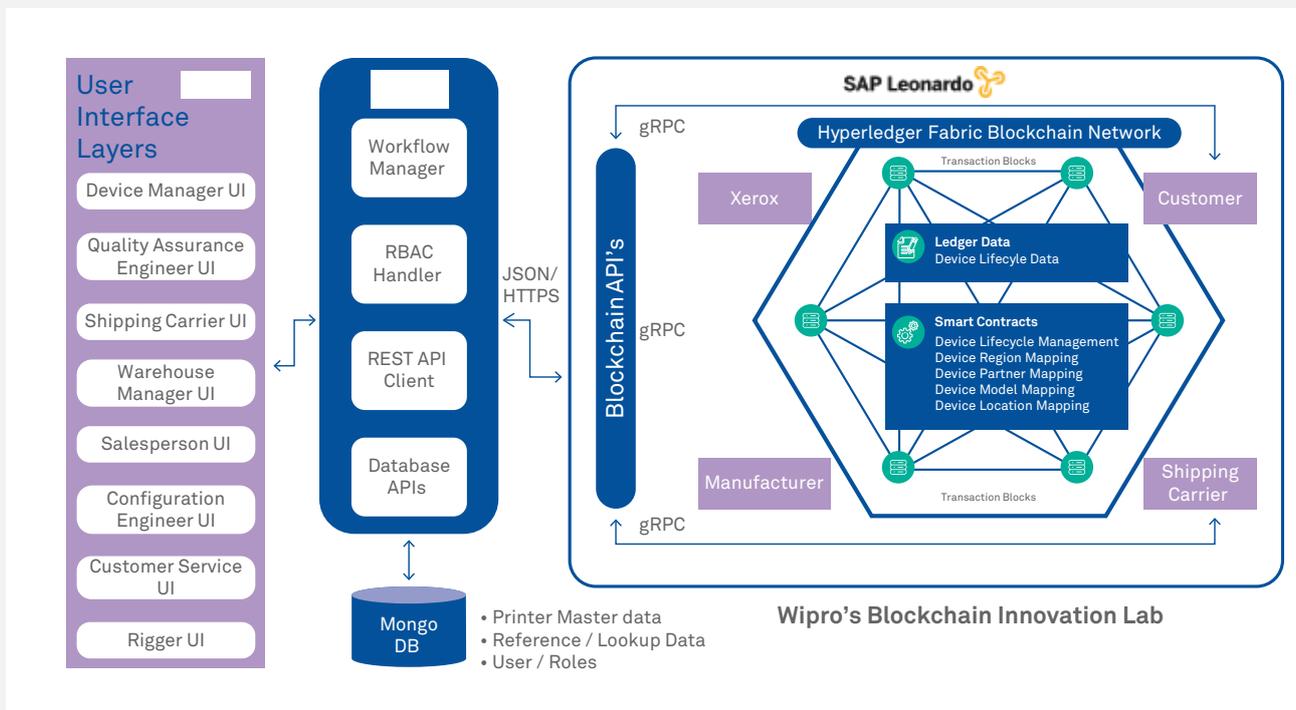


Figure 1: The POC’s Architectural Model

The POC’s technological focus was to evaluate the values of specifically Distributed Ledger Technology (DLT) and Smart Contracts cross-database across the Xerox value chain for mid-volume printers. It demonstrates that Xerox can use blockchain’s DLT capabilities to show a single, unambiguous view of overlapping, parallel, and corresponding data stored in and across multiple systems at multiple companies by enabling an enterprise-grade distributed database architecture complimented by a new customized User Interface (UI) that would best optimize usage of these new data interaction capabilities.

From an Enterprise Architecture point of view, where you have many systems that hold the same or overlapping data, it becomes increasingly difficult to tell which data is the correct data and identifying the ‘Golden Sources’. This issue is compounded when employing systems integrated with external systems that provide vital supporting information.

The purpose of this white paper is to contextualize and share the lessons learned from this POC so as to further enable others who want to adopt blockchain-related DLT technologies. In particular, we look herein to fundamentally challenge our hypothesis: that using blockchain-related technologies cross-value

chain will increase a given company's ability for the successful Digital Transformation of their overall enterprise architecture.

A Common Problem: Trying to make it better makes it worse

With many companies, as technology bloat occurs and human understanding declines, the quality, cost, and delivery metrics of a given organization are at risk of declining at an ever-accelerating rate. Even when tightly managed and optimized, each new feature, vendor, database, and system can reduce a company's ability to add the next feature, vendor, database, or system and maintain the existing ones.

A typical situation faced by enterprise architects plays out as follows:

- A specific legacy system or process becomes an obvious, costly, time-consuming issue for a given business area or product line.
- The business takes action and allocates funds for a new system to be designed and implemented or procured.
- The new system is optimal and made available to the enterprise but is offered as optional and is not adopted by all regions and business lines because they are not required to and additionally they would need to spend their own budgets (e.g. to migrate or retire existing legacy systems, connect their systems' databases to the new databases, etc.), which, in turn, they too often perceive as a penalty given the negative impact to their profit and loss (P&L) metrics.
- The new system becomes just another one among many similar systems and therefore adds to the overall complexity of the company's Enterprise Architecture and creates more problems than it solves.

Of course, companies employ Enterprise Architecture (EA) to prevent just these types of problems and it's the enterprise architects' role to design and deploy coherence and simplicity throughout an organization. So why do systems decay into complexity and why can't the enterprise architects prevent, or at least fix, these problems?

Typically, different business units, subsidiaries, and regions within a large multi-national company will have independent authority to manage the systems and vendors they use and in managing related budgets for upgrades and changes. So it

is common to see decisions based more on generating near-term revenue than on seemingly costly maintenance activities or operational upgrades that will not provide a clear, understandable return in the short term. Conversely, enterprise architects typically do not have the authority to force enterprise-wide retirement, conversion, adoption, and implementation of systems regardless of the immediate or long-term technical value, nor the collective enterprise funding to be ultimately recaptured.

As issues arise due to this proliferation of redundant systems, businesses need solutions that allow various operational groups to agree on a single, trusted version of the data and a single set of systems to support each business capability. Blockchain could provide a way.

Enter blockchain: The EA enablement solution?

It has become common for people to think of blockchain as a core element for "Digital Transformation" as it is widely thought to address many of the existing limitations in increasingly complex supply chain, business service, and data management situations.

The core hypothesis has become that blockchain, most specifically DLT & Smart Contracts, can provide the basis for both saved revenue and new revenue streams by supporting new inter-system orchestrations. While it's important to note that there are risks to deploy blockchain-based solutions at this time because the technology is immature agreed-to standards and have not yet emerged, these 'known unknowns' in the current landscape will most likely be resolved only via real businesses doing real testing, using, and adopting consistently over the next five-to-ten years within the realm of their overall digital transformation and enterprise architecture strategies. As Michael Jordan said, "To learn to succeed, you must learn to fail". And while business leaders, especially Chief Information Officers and Chief Technology Officers, are pressured to digitally transform at the risk of prospective corporate demise, we are still left with questions of whether using blockchain-based protocols now will result in the addition of future costs and complexities.

But we believe that, at the end of the day, the unique abilities around decentralized database management (DLT), encryption, immutability, transparency, and work process automation

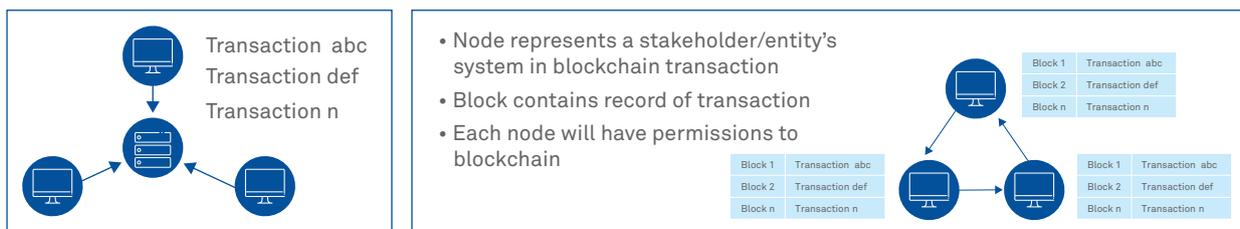
(smart contracts) that blockchain enables are foundational to many core EA aspirations and are worth experimentation.

In an effort to test the viability of these outcomes, the promise of blockchain, and whether we might achieve a main goal of all enterprise architects – digital transformation – Xerox and Wipro chose a business problem to develop a blockchain-based solution that would simultaneously test a DLT protocol (the open sourced Hyperledger Fabric), Smart Contracts, a BaaS provider (SAP’s Leonardo), user interface (UI) selection and user experience (UX) development via Crowdsourcing. The following shows how an Enterprise Architecture group can make the promise of Digital Transformation and system optimization more likely using blockchain.

Why consider a blockchain-based Distributed Ledger versus a traditional centralized Database?

From a basic technology viewpoint, a DLT is a distributed database that’s used as a ledger to record business transactions that normally involve transfer of tangible or intangible assets. Each time a transaction is completed, a new “block” of information is respectively added to the blockchain’s linear chain of blocks. Each block represents a transaction and specific related data. The new block documents the important details about that new transaction and all related elements and is irrevocably linked to the previous block in the chain. If a transaction is not completed for whatever reason, no block is created. Additionally, each node in the distributed database stores an encrypted copy of the entire blockchain (database) at all times.

Traditional System versus blockchain-based DLT system



Differentiator	Database	Blockchain
Network	Centralized; client server based	Decentralized; peer-to-peer cross-server network
Storage	Data is stored in central server	Data is stored as blocks in each node in the network
Data Integrity	Transactions persisted to a traditional database system can be altered or deleted anytime, whether intentionally or via hacking	All transactions persisted to blockchain are immutable; records can only be appended (updated) and all nodes must respectively record the event and be in consensus
Cyber Security & Cryptography	Vulnerable due to single point of failure and lack of cryptographic encryption by default	System can't be compromised by single point of failure and all data is encrypted; every transaction must be digitally signed using public-private cryptography

Figure 2: Traditional distributed databases versus blockchain: how a distributed database allows multiple parties to transfer, store, and protect sensitive data/information in a space called blocks.

While much of this can be implemented with a standard distributed database, blockchain adds additional elements not normally found in traditional databases including trust in workflows where trust doesn’t exist, universal verifiability, the encrypted storage of private or sensitive data in public or more widespread databases (i.e.

hiding in plain sight), and a whole slew of new cybersecurity capabilities including consensus methodologies, immutability, and atomic operations (meaning transactions run independently of each other so no two operations can interact with or interfere with or corrupt each other).

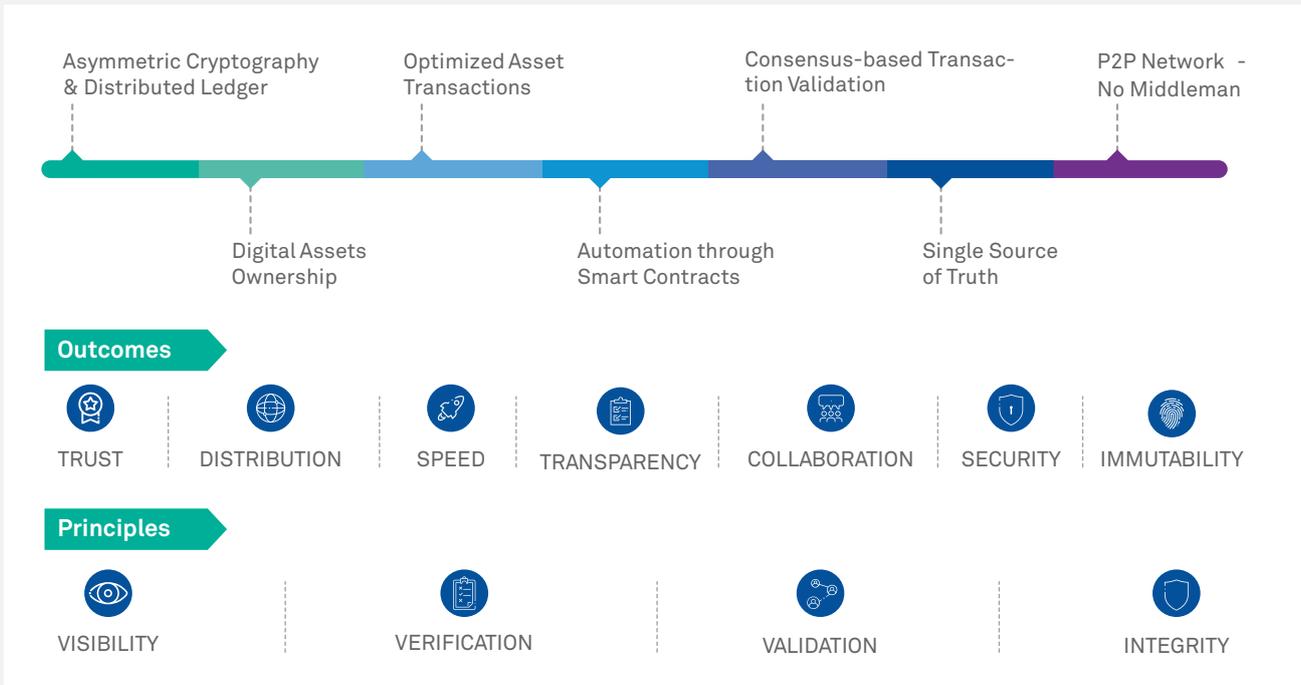


Figure 3: Blockchain POC enablement: pre-identification of targeted values and defined outcome expectations are vital.

What Xerox and Wipro Designed and Built

Many industrial workflows and value chains have multiple participants who provide different information at different times. Many of the participants don't know each other or don't interact directly, often intentionally. The databases are often not integrated. Sometimes the databases contain identical content but with different data formats and different semantics from the same or different sources.

For our purposes, SAI decided to focus on a Xerox-related value chain – the print hardware lifecycle – that has these characteristics. This Printer Lifecycle Proof of Concept (POC) intended to demonstrate how blockchain can be used to provide new levels of visibility into the print hardware lifecycle.

Wipro built a blockchain application that tracks Xerox devices through their lifecycle, up to their installation at customer sites. In doing so, this POC showed how DLT supports the autonomous functioning of each supply chain element using the existing systems and business flows (as Figure 4 shows in abbreviated form) while enabling consistent information across the value chain for Xerox and its partners. For purposes of the POC, the value chain elements included were:

- Delivery from the manufacturer
- Warehousing / Print Hardware Inventory
- Sales: Device contracted to a customer
- Device configuration for the customer
- Delivery to the customer
- Installation at the customer site

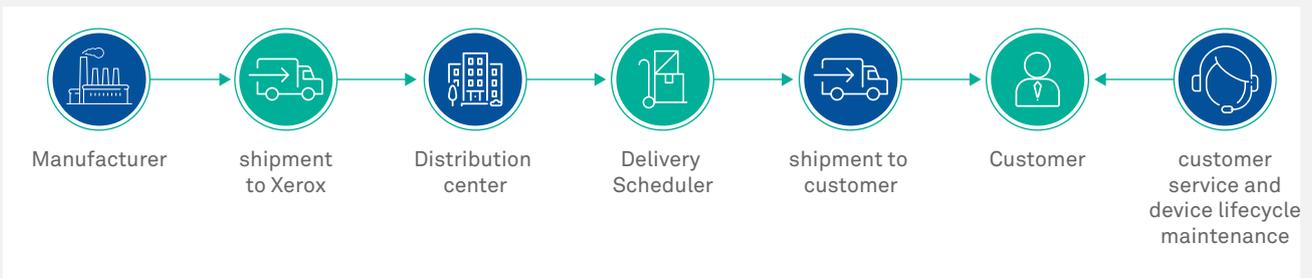


Figure 4: POC Overview – an abridged, generalized view of Xerox's Diverse Supply Chain for large printers.

Due to scope limitations, the POC excluded other lifecycle elements such as equipment use by customers, model reliability, and product retirement and disposal. However, these were not needed to make the point that the POC successfully demonstrated: blockchain can enable providing a unified and trusted view of a value chain with diverse participants and diverse data without taking the expensive step of integrating the various systems and rationalizing their duplicated data.

As Figure 5 illustrates, the blockchain DLT when coupled with the corresponding UI acts as a single abstract user interface supporting across our diverse value chains. For example, an analyst could access the blockchain for any required value chain information. Note, for purposes of the POC, the underlying data elements and blockchain that support the user interface were graphically represented so that someone unfamiliar with blockchain can understand what is happening and how it is happening as a device progresses through its lifecycle and blocks are added to the blockchain.

We found several, multi-dimensional benefits of deploying a customized user interface on top of a privately deployed blockchain, including but not limited to:

- For individual devices, it allows the user to pick a particular device by serial number or filter the display to show a device's current geographic location and/or all of its previous locations (e.g. manufacturing facility; warehouse; customer site; disposal facility) on a map.
- It allows the user to select a particular model and filter the display to show a map of current and/or previous locations of all instances (individual devices) of that model. The map itself is interactive and can provide further granular details such as number of devices within a nation or in a city, the number of said devices at a given customer site, and even zoom in to inspect an individual device.

We also created a dashboard that shows each device's history up to its current location and configuration. The user interface was designed and implemented by Wipro's Topcoder division which uses crowdsourcing to design, implement, test, and deploy software, then further tested and integrated with the DLT by Wipro's Blockchain Practice. From 16 submissions, we worked our way to 6, then 3, and finally to 1 ultimate winner.

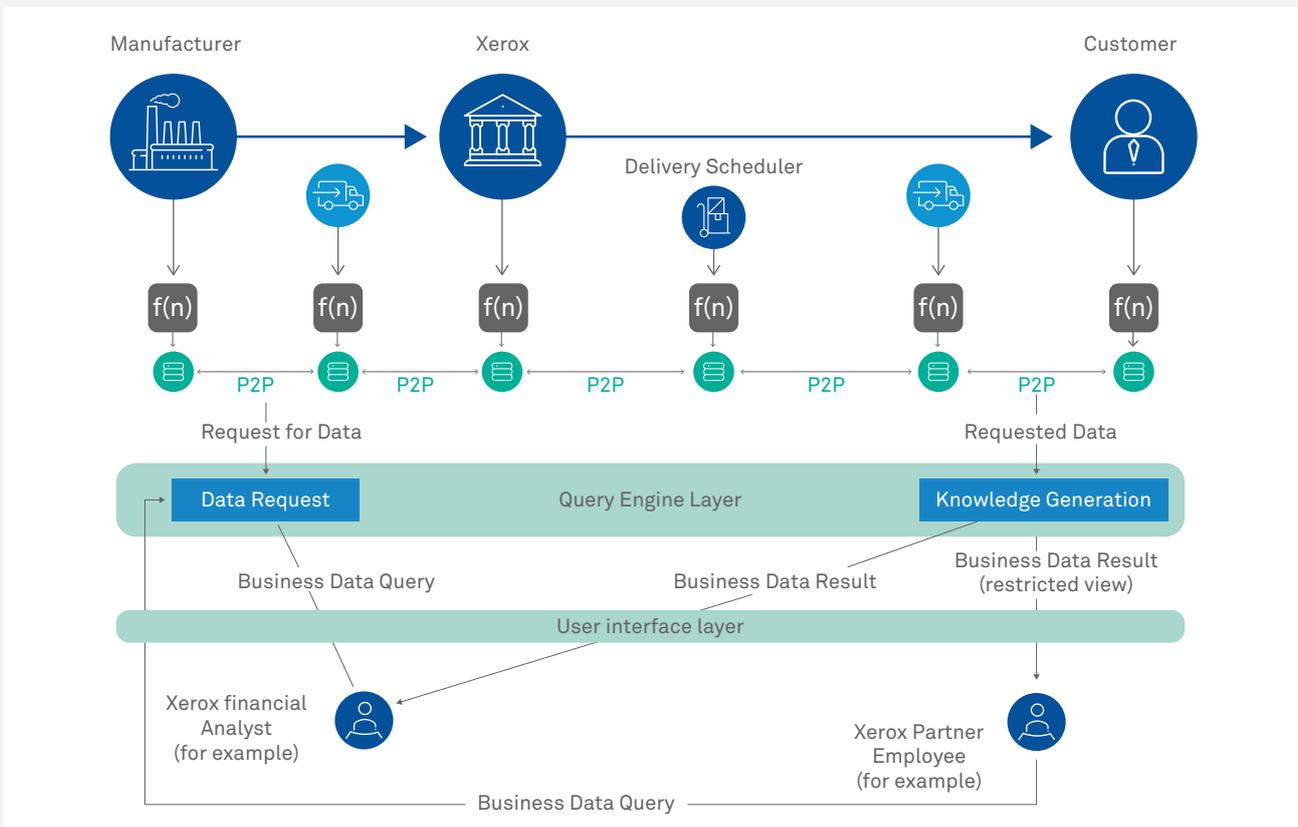


Figure 5: Using blockchain as an abstract interface to integrate cross-value chain and optimize operations & client support.

In addition, the POC demonstrated how smart contracts encoded onto these DLT protocols can

be used to automatically increase value chain efficiencies (see Figures 6 and 7).



Figure 6: POC Overview – Automating Value Chain Steps

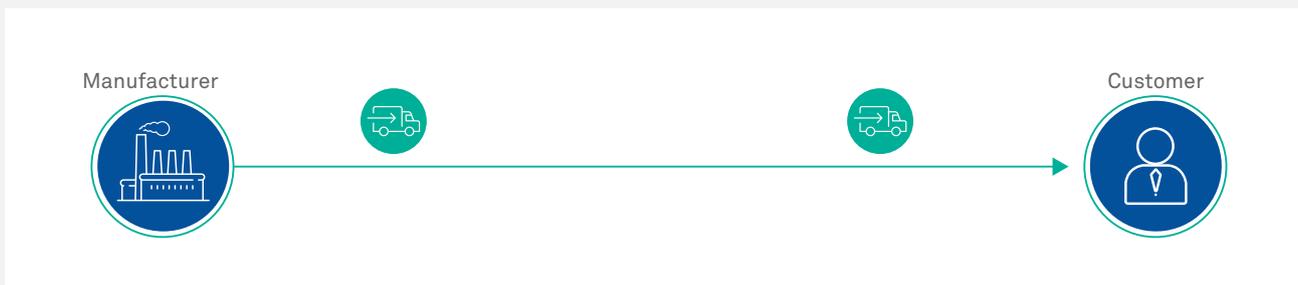


Figure 7: POC Overview – Reducing Inventory Using Smart Contract Automation

In this scenario, Smart Contracts enable Xerox to reduce its inventory by shipping directly from the manufacturer to the customer, bypassing the Xerox warehouse, as per below flow:

- A new device is assigned a serial number before it is manufactured.
- The manufacturer enters that serial number in its database which triggers the creation of a new block on the blockchain. A Smart Contract sends the serial number, information about the device, and its projected completion date to a Xerox sales database.
- A Xerox salesperson then sells the device and includes the serial number in a contract, even though the manufacturer has not yet built it.
- After the customer signs the contract, a Smart Contract orders a pickup from the manufacturer for the appropriate date and with the customer's ship-to address as the destination. As shown in the second figure, the device spends no time in the warehouse inventory, reducing everyone's costs.

What Xerox and Wipro Learned

There are several business capabilities where blockchain can bring value to Xerox. They all share the common characteristic of having multiple databases that contain replicated and/or overlapping data. As described above, in these

situations, blockchain can act as an abstract interface that delivers the single, trusted version of the collective data to all the people and systems that need any of this data to operate.

It's important to note that, while this POC taught us a lot about blockchain, the technology is still in its beginning stages. And while the main purpose of deploying blockchain has been to establish trust in areas where, for one reason or another, trust does not exist, various questions similar to the following have been raised about why we should or would use blockchain rather than other more standard methods and tools:

- Why use blockchain when we could use standard shared (or distributed) database technology?

Standard shared and distributed database technologies cannot prove that the version of the data being displayed can be trusted.

However, when deciding whether to use blockchain, it's important to be very clear about why you should use blockchain instead of a standard database. You should apply specific criteria and rigorously adhere to those criteria. Otherwise, blockchain may cause more problems than it solves (at least in its current immature state).

- Why use blockchain when we could use our (and our partner's) existing systems with a new abstraction layer and new APIs to provide the same information?

In this POC, the DLT performs exactly this role. It acts as an abstract interface to the various systems owned by the various value chain participants.

There are several ways to achieve this kind of abstraction. However, except for blockchain, none of these methods enforce the trust that this POC intended to demonstrate. Therefore, blockchain is the natural choice for this kind of application.

- Is notarization (immutable timestamps) a sufficiently compelling application of blockchain to make it worth using (versus a regular shared database)?

Without notarization, blockchain's trust mechanism will not function. And trust is, of course, blockchain's main point. Therefore, notarization is a crucial element for bringing trust to a situation involving the reliable use of replicated data.

- Is transparency a sufficiently compelling application of blockchain to make it worth using (versus a regular shared database)?

Blockchain provides natural transparency that enables any authorized user to trace any data element from its creation to its current state. This level of transparency is crucial to ensuring trust in transactions and can be permissioned on a person-by-person, data element-by-data element basis. While other databases could enable this level of transparency, blockchain comes with other mechanisms (notarization, immutability, single instance, etc.) that together make trust absolute in blockchain networks.

To achieve the same level of transparency, we would have to retrofit most of these mechanisms into existing systems. And even then they would be deployed without the existing proof of effectiveness that blockchain already demonstrates.

Blockchain as an Abstract Interface to a Business Structure

Over and over we have found that copying the same data to multiple databases causes disastrous results in crucial business processes such as billing. Because Xerox has not prioritized eliminating all of this redundancy, the complexity of these systems continues to increase, in turn

producing higher costs, slower delivery times, and lower quality solutions. This POC was not meant to rationalize all of the duplicate data and systems of the POC's supply chain in focus. Instead, it intended to demonstrate a mechanism whereby all of the various value chain participants can (if authorized) see and trust one version of the data. Our POC shows how blockchain can act as an abstract interface to data and technology as well as how it can act as an abstract interface to a business process. Because even if you could magically eliminate all complexity and incoherence in a company's systems, as we have seen, complexity will continue to reemerge because the root cause of the problem – the company's business structure – has not been solved.

Theoretically, applying what we learned in the POC enterprise-wide, we may reduce the chance that the business's structure will generate system complexity as:

- We can use blockchain as an abstract interface to the business structure.
- We can use Smart Contracts to generate incentives that cause the various silos to adopt the corporate-level infrastructure and operations.
- The divisions into business silos (region/offerings) can remain in place so that each silo can continue to serve its local customers effectively and the local teams can continue to operate largely autonomously.

Figures 8 and 9 extend this thinking in showing how blockchain might act as an abstract interface to a business's structure, and how, in the same way that blockchain can be used as an abstract interface to diverse systems, we can thus theorize that it can be used as an abstract interface to business structure and technology infrastructure.

Accordingly, in Figure 8, when any update occurs in any silo, it is appended onto the blockchain as a particular type of change. The analyst looking for a state change can see all of the business silos as if they are a single entity.

Figure 9 shows the human-understanding map for this idea. It is conceptually simpler for the end user compared to what's required in their typical situation.

Using DLT as a decentralized interface

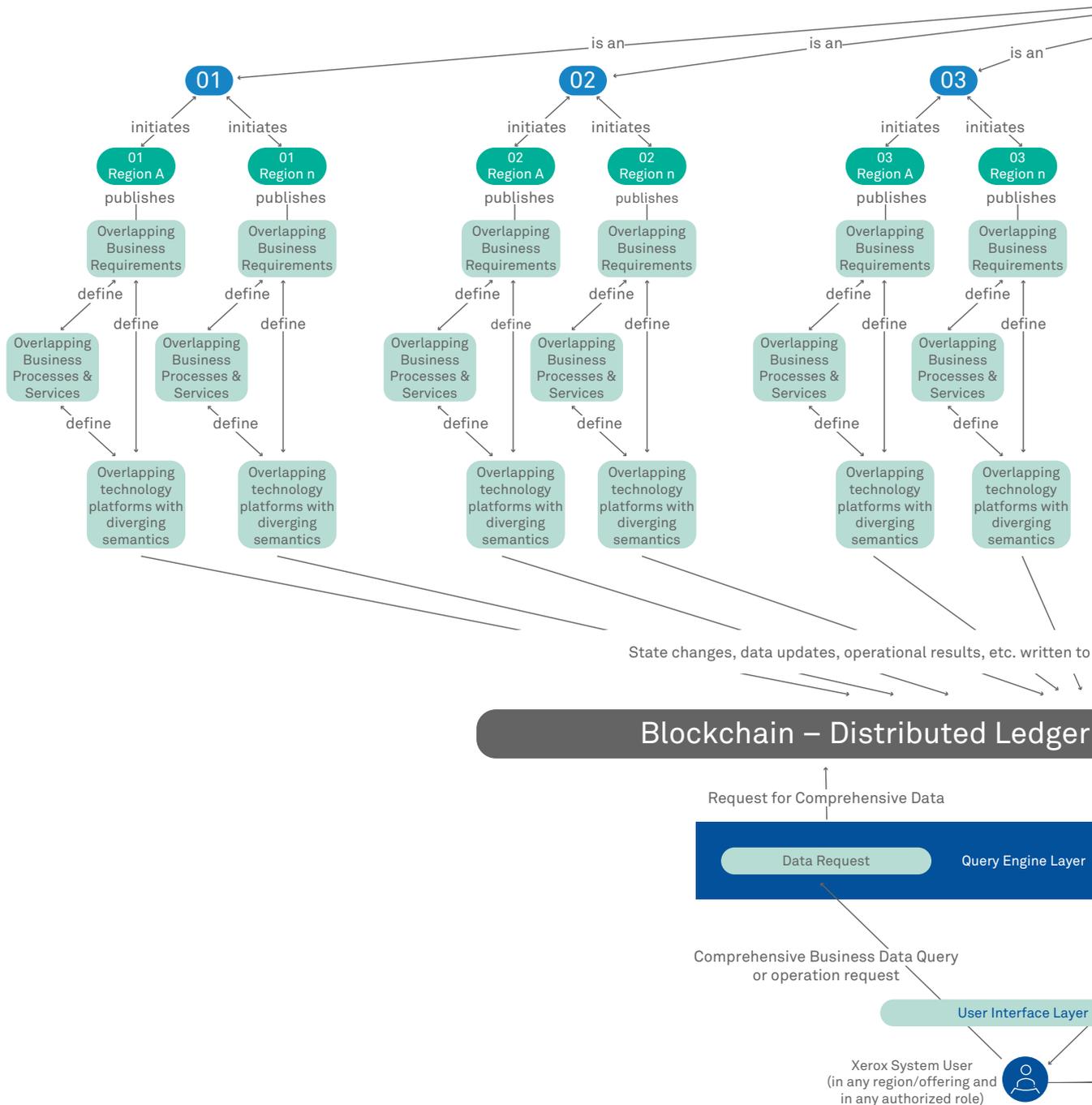
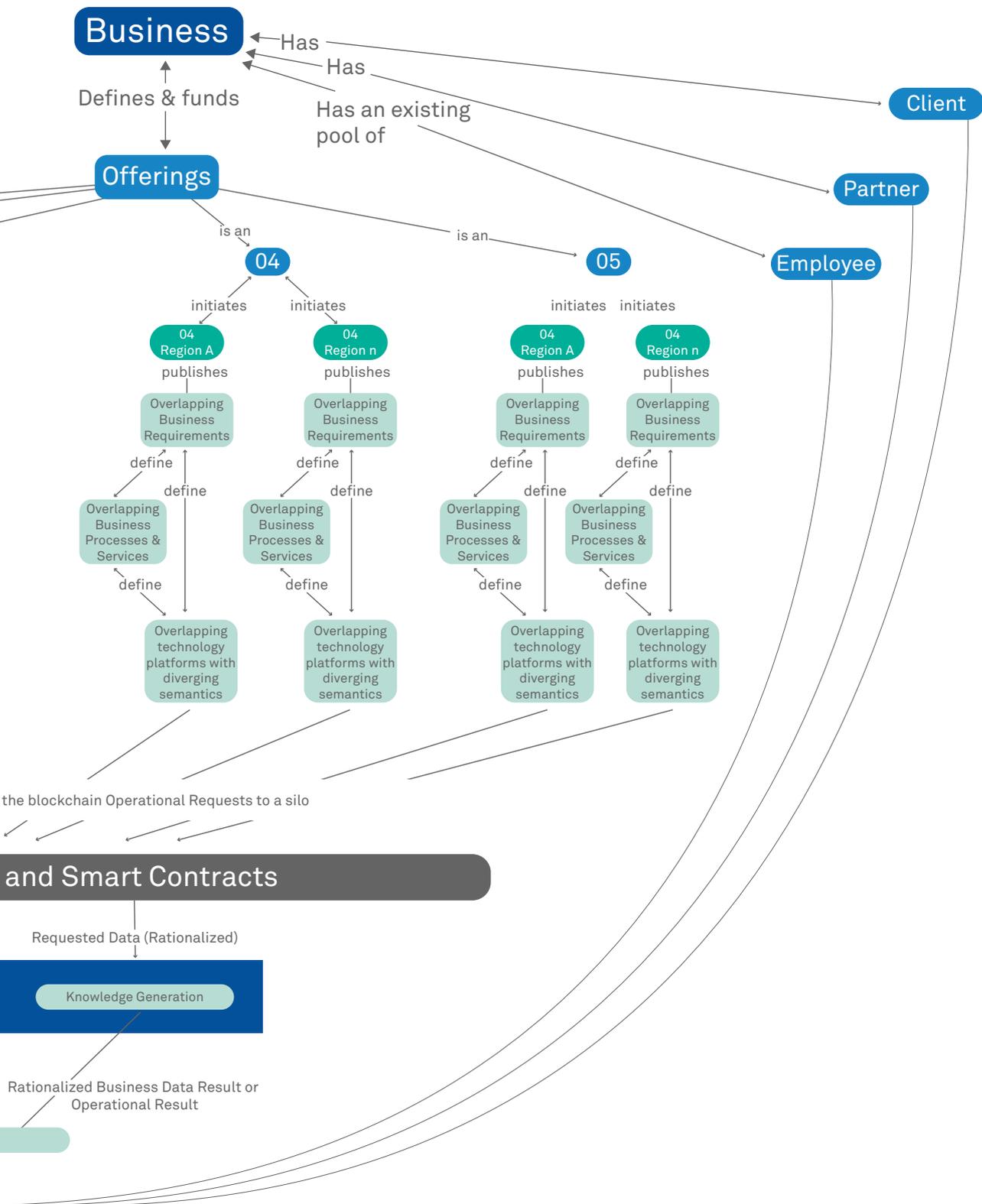


Figure 8: As the improved systems function, the blockchain can record its operations and they can values can be reliably calculated

across organizational silos



be compared to the pre-improvement operations so improvement and return-on-investment

The User's conceptual view through the decentralized interface

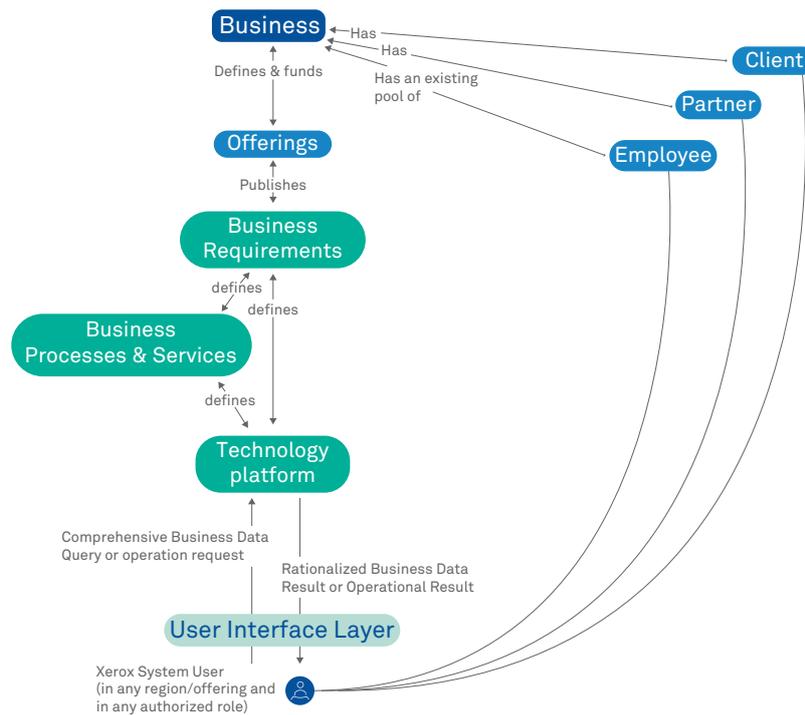


Figure 9: The user sees through many silos as one silo (one set of business processes for a business capability, one set of data, and one set of operational requests)

Conclusion

This paper describes a testable theory; our hypothesis stated that using blockchain-related technologies will increase the chance that a company's digital transformation of their enterprise architecture will succeed. With a focus on supply chain optimization, this proof-of-concept proved that this is possible and moved us towards a new understanding for re-articulating enterprise architecture design and theories.

At the end of the day, in line with this theory towards digital transformation, we must consider the Enterprise Architect as the person who repairs decayed technology and business processes so the company can thrive. Where Enterprise Architects are enabled to optimize and consolidate systems and processes cross-business in a given organization and also employ blockchain technologies, especially DLT and Smart Contracts, we believe that over time there will be less need for digital transformation as companies will be able to focus more on the true promise of digitization: ongoing innovation atop a solid technical foundation.

Selected readings

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Don Tapscott and Alex Tapscott: Blockchain Revolution

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With over 18 years of global diversified experience, Joshua has been previously instrumental in creating, managing, and scaling transformational growth as well as leading operations & regulatory support for top-tier financial services & consulting companies. His areas of subject-matter expertise include Blockchain, FinTech, Trading Operations, Financial Services, and Enterprise Business Architecture. He has a Bachelor's Degree in Economics & Sociology from Fordham University, an Executive Master's degree in Business Administration from Fordham University, and a Master's degree in Urban Affairs from CUNY-Hunter College.



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