



Product life cycle management on a blockchain network

Using a foundational, new technology to change the way we manage regulated data for drugs and medical devices

The EY logo consists of the letters 'EY' in a bold, white, sans-serif font. Above the 'Y' is a yellow chevron shape pointing to the right.

Building a better working world

“To date, blockchain has transformed only people’s thinking. We don’t yet even know all the questions blockchain technology will raise, much less the answers. But waiting for the technology to take hold is too late. Now is the time to start defining the questions and influencing policy that will lead to answers.”

Channing Flynn

Global Technology Industry Tax Leader
Tax Services





Pharma companies have complicated supply chains and manufacturing operations that are closely regulated by health authorities (FDA, MHRA, etc.). There has recently been a significant increase in the volume of regulatory findings around data integrity issues, which can also be viewed as a lack of trust in digital records. While the lack of trust can stem from many places, it is often traced back to two primary drivers:

1. Inconsistent data across multiple sources over time (where is the source of truth)
2. False data (either accidental or fraudulent) that was not detected and corrected in a timely manner

While these issues can manifest themselves in many different ways across an organization, most pharma companies need to look no further than their own efforts to compile their Product Quality Reviews or Annual Product Reviews (APRs). Though the requirement for APRs in the US have been around since the amendment of 60 FR 4091 in 1995 (now 21 CFR PART 211, Subpart J, Sec. 211.180); 23 years later, companies still spend an exorbitant amount of non-value-added effort to track down records associated with their products and compile their APRs (year over year). This is just one example where a combination of the lack of trust in the data and the complexity of retrieving and managing data across multiple systems, organizational units and third-party provider's results in an inefficient process that is subject to undue risk; likewise, it results in a prime opportunity for disruption.

Blockchain offers the prospect of designing a data structure from the perspective of the product; meaning that in a single chain all vital data about that product can be captured directly at the source of origination and maintained in an immutable audit trail. Because the blockchain has no central authority, complex system integrations are not required to produce a single data thread along the entire product life cycle. Further, the timestamping function of the blockchain, in conjunction with the audit trail, provides an accurate record of who, what, where and when a product might have been changed over a given period of time. The current status/location of any given product is available by examining the current state of the block.

The cost of data integrity and availability

The real cost of data integrity and availability is the amount of effort an organization puts forth producing data they can trust. If we imagine a world where all data is trustworthy and at our fingertips, then the efforts around data would be limited to affirming that it accurately reflects our real-world transactions and processes (controlling inputs) and in interpreting the data to make better business decisions (understanding outputs). Any time or resources spent on trying to locate, verify and conform data is a sunken cost that yields little return. Yet this cost is significant; in July 2016 the FDA issued a draft of their proposed Request for Quality Metrics, the Federal Register Notice (80 FR 44973) gave a total industry estimate of 667,800 hours annually to collect and respond to their 15 proposed metrics.¹ A follow-on study conducted by the International Society for Pharmaceutical Engineering (ISPE) in in June of 2016 determined that the actual effort would be at least three times that amount.² And that was just to collect and prepare data on three of the metrics; that should be relatively straightforward. For further evidence of the effort to harmonize data across the product life cycle has become apparent in the millions of dollars that companies are spending to become compliant with the serialization standards that come into effect in November 2017.

And these upfront costs can be just a drop in the bucket when compared to the cost of getting it wrong. From an FDA perspective the inability to rely on data will create major obstacles in new drug approvals (a recent clinical trial inspection by Health Canada found Argos Therapeutics states “did not keep complete and accurate records to show the clinical trial was conducted in keeping with Good Clinical Practices and Regulations”³) and can result in warning letters, which may lead to injunctions. These trends in data integrity issues have been so obvious that in April 2016, the FDA issued a draft guidance for “Data Integrity and Compliance with CGMP.”⁴ An underlying theme is that trust in data can be easily eroded and can take years to regain.

Living in a database world

We live in a database world governed by systems that each lay claim to certain aspects of our daily lives; those systems each have their own databases – which are their truths within their span of control. These systems and databases are innocuous to our everyday lives; our purchases may be governed by credit card companies, our investments by our brokerage systems, our phone calls by our cellular service provider, our health records by our insurance companies – even children’s report card are stored in a database that can be retrieved online. Built-for-purpose systems and their databases are everywhere; we often don’t consider the amount of technical effort it takes to connect things and the leap of faith that it takes to assume the information is correct, not to mention the huge risk presented by storing everyone’s data in a central repository – as we learned in some of the recent publicly visible hacks, one database can provide a hacker access to millions of accounts (for example, the 2015 hack of Anthem Inc. disclosed records on 78.8 million people.⁵ Today’s systems have been built for specific purposes and are designed to govern their portion of the big picture – the same way – for all of the millions of transactions that may be passing through them at any given moment. They were designed to handle volume over a short span, not to handle a single transaction over a long span.

1 *Federal Register*. (2015, February 28). Retrieved May 09, 2017, from <https://www.federalregister.gov/documents/2015/07/28/2015-18448/request-for-quality-metrics-notice-of-draft-guidance-availability-and-public-meeting-request-for-Table-1-Estimated-Annual-Reporting-Burden>.

2 ISPE Quality Metrics Initiative Quality Metrics Pilot Program Wave 2

3 *Clinical trial inspection report card summary*. (2016, February 08). Retrieved May 09, 2017, from <http://healthycanadians.gc.ca/apps/gcp-bpc/fullReportCard-en.html?lang=en&gclid=28500eeefda4-4cff-b4f3-8c627c4359c0>

4 *Data Integrity and Compliance with CGMP*. (2016, April 14). Retrieved May 09, 2017, from <https://www.fda.gov/downloads/drugs/guidancecomplianceregulatoryinformation/guidances/ucm495891.pdf>

5 *Anthem medical data breach*. (2017, May 07). Retrieved May 09, 2017, from https://en.wikipedia.org/wiki/Anthem_medical_data_breach

“We recommend companies not focus on how this technology fits into their current business, but instead look at what their products and services look like in a blockchain-enabled world.”

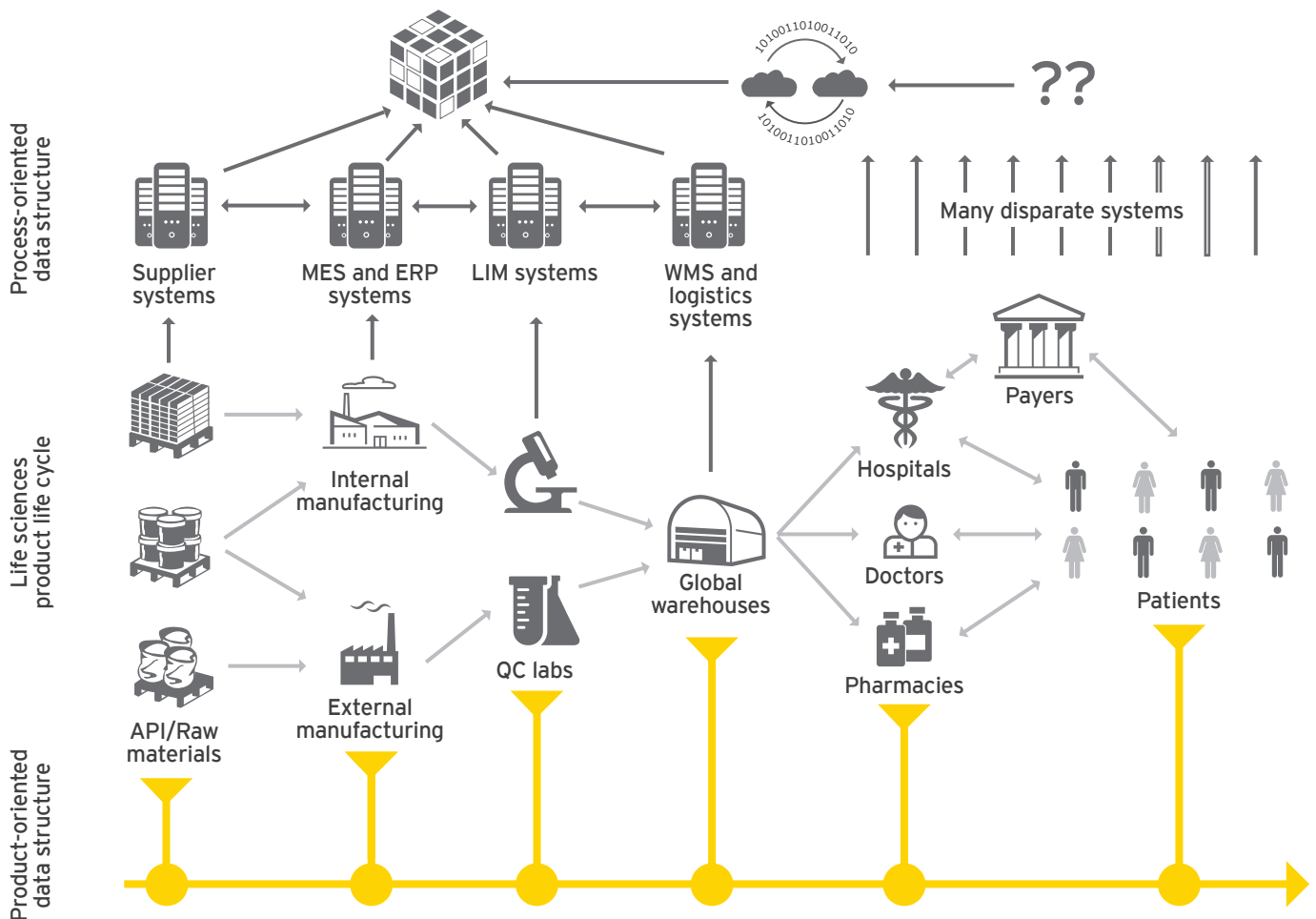
Angus Champion de Crespigny

Financial Services Blockchain and Distributed Infrastructure Strategy Leader
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But it doesn't need to be that way – by simply flipping the script to design data structures to be “product-oriented” as opposed to “process-oriented,” we can begin uniting data along the life cycle of a product and break down the cumbersome handoffs between our databases. For example, take a bottle of over-the-counter acetaminophen; in theory, the manufacturer's name, product SKU and LOT number are enough uniquely identifying information for someone (the manufacturer, pharmacist, consumer, regulators, etc.) to be able to look up everything they would need to know about that product. In the product-oriented view, one data stream

would contain all of the information, and as long as one were able to access that data stream, one could have access to everything they were entitled to see. If someone were to gain unauthorized access, their ability to see data would be limited to that single stream. By contrast, following a process-oriented data structure to generate that same information would require multiple calls to multiple databases and demand a coordinated master data approach by all systems involved. Should a malicious individual gain access to one of those databases, they potentially could affect the integrity of all records, across all products that are stored there.

Figure 1: Process vs. Product orientation of data structures



Understanding blockchain technology

Blockchain technology is a way to structure data without the need for a central authority. A blockchain is a distributed database that hosts a continuously growing number of records. The database stores records in blocks rather than collating them in a single file. Each block is then "chained" to the next block, in linear, chronological order, using a cryptographic signature; as a result, records cannot be revised, and any attempted changes are visible to all participants. This process allows blockchains to be used as ledgers, which can be shared and corroborated by anyone with the appropriate permissions. These distributed ledgers can be spread across multiple sites, countries or institutions. Although blockchain technology is the foundation for cryptocurrency (such as bitcoin), there are a variety of business applications beyond the realm of cryptocurrency.

Based on the participants, blockchains are categorized as public, private or hybrid. This is similar to comparing the public internet and a company's intranet.

- ▶ **Public and permission-less:** Public and permission-less blockchains resemble bitcoin, the original blockchain. All transactions in these blockchains are public, and no permissions are required to join these distributed entities.
- ▶ **Private and permissioned:** These blockchains are limited to designated members, transactions are private and permission from an owner or manager entity is required to join this network. These are often used by private consortia to manage industry value chain opportunities.
- ▶ **Hybrid blockchains:** An additional area is the emerging concept of sidechain, which allows for different blockchains (public or private) to communicate with each other, enabling transactions between participants across blockchain networks.⁶

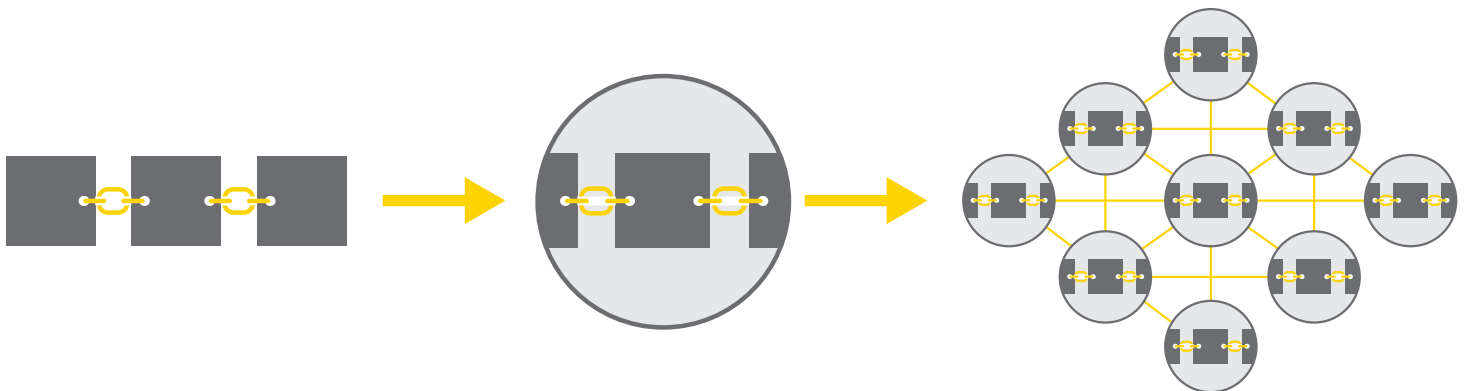
⁶ EY (n.d.). *Blockchain: How this technology could impact the CFO*. Retrieved May 06, 2017, from <http://www.ey.com/gl/en/industries/technology/ey-how-blockchain-technology-could-impact-the-cfo>

Figure 2: Distributed ledger structure

A blockchain is made up of a series of blocks containing validated transactions.

Each block is attached to the previous block, thereby making it extremely difficult to corrupt, helping to combat fraud and allowing for accurate and complete information.

This chain of blocks is then stored and replicated across the network, enabling a distributed ledger.



“If organizations cannot trust their data, they cannot claim to be compliant. When data is visible, immutable and controlled it is much easier to trust; blockchain allows for all of these things, making it a strong foundation for compliance.”

James Canterbury

EY Global Life Sciences Risk & Compliance Leader
Ernst & Young LLP (US)

Combining the idea of a product-based data stream for a pharmaceutical or medical device with the autonomous nature of blockchain technology creates a data stream with some very attractive properties:

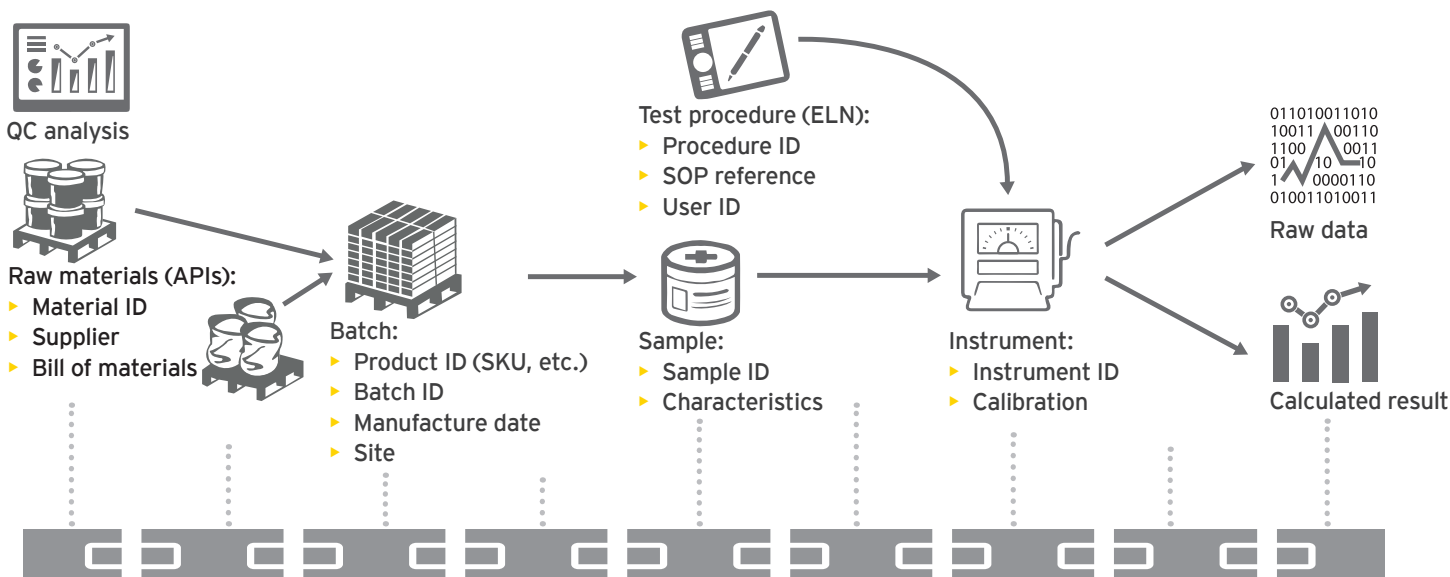
- ▶ **Consensus** across the entire network on what is true at any given point in time – blockchain was built to make trust inherent; organizations do not need to go to exorbitant extents to prove their data is accurate and complete.
- ▶ Trust is further gained by having **an immutable audit trail** that is the result of storing the hash of a previous block within the header information of the current block. Hashing of previous hashes makes it nearly impossible to change anything that was written to the blockchain without a record of what was updated.
- ▶ **Encryption** of certain data keeps portions of the blockchain visible to only authorized nodes on the network.
- ▶ Product blockchains are very good at telling **exactly where** a product is in its life cycle and **who has ownership** of it at any given point in time. By using pointers and hashes, blockchains can also tell us which procedures were in effect and which equipment was used at each stage in the life cycle.

- ▶ **Data integrity** gets a big boost in nearly every component of ALCOA+ (being legible requires having access to a node that can view data and having software that can read blockchains).
- ▶ Using smart contracts (small pieces of code/logic that are imbedded into the blockchain), **controls for how the product should be handled under certain** conditions can be enforced without relying on the systems that govern the process. For example, when a product has passed its expiration date, a smart contract can prevent it from being picked and shipped without relying on the warehouse management system to enforce the control.

What would a blockchain look like for a pharma product?

To design a blockchain that would capture the data along the life cycle of a pharma product, we would likely start at batch creation and follow it through to the smallest saleable unit. Because blockchains can refer to other blockchains (the hybrid model), companies will likely begin with blockchains that collect data from processes that are within their span of control. These may include external manufacturers or distributors. Data would be collected at the source of origination (the actual equipment used to manufacture/test/package the drug), and each block would be a combination of Identifying data, status/stage data, supporting data and timestamp information. The blockchain can be run in parallel with existing MES, LIMS and ERP systems.

Figure 3: Example blockchain for QC lab



Making it real

Blockchain technology is still in early stages of development and it will likely take some time before its full potential is understood and put to use. This technology has the potential to help life sciences companies to simplify complexities while providing them the ability to uphold their data integrity standards within a regulated environment. Breaking away from a database mentality may be the most challenging IT cultural/mindset shift ever, but companies don't need to wait until someone else has set the standard. With guidance from EY you can begin experimenting and developing blockchain concepts with a very low barrier to entry.

EY is a blockchain technology leader. We understand the implications of a distributed world and have been helping our clients strategically plan and implement blockchain solutions across industries. The following thought leadership about blockchain can be found by searching ey.com.

While this paper focused on gaining efficiencies and data integrity, these are just two of the potential benefits; below are additional applications of blockchain technology that can disrupt traditional business practices within life sciences.



Blockchain in health



Implementing blockchains and distributed infrastructure



Blockchain reaction



Blockchain technology as a platform for digitization



Blockchain: the hype, the opportunity and what you should do



With blockchain what comes first, opportunity or threat?

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