

QUALITY-BY-DESIGN-ENGINEERED BLOCKCHAIN SOLUTION FOR PHARMACEUTICAL PRODUCT DEVELOPMENT

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Context: In the past few years, health product development has been tainted by numerous trials where some manufacturers of medical devices have been accused of omitting or falsifying data in order to receive marketing approval, thus lowering trust in the system. Digital Health has not escaped this trend with the risks on the patient's personal health data. To this can be added the advent of wearable sensors generating longer and longer personal data and requiring new solutions to protect them and to better ensure their integrity.

Aim

Our aim is to **remove the historical untrusty third party** known as the manufacturer whom is by oneself, for now, sending data to the Notified Bodies and European Medicines Agency after collecting them from laboratories. As seen in Fig. 1, we hope to make laboratories' IoT sensors directly store their **big data flow** into a blockchain hosted by every stakeholder, ensuring for everyone **trust in the data generated**. The culprit, here, is to define a solution that could manage said flow without sacrificing Quality of Service or Quality of Experience.

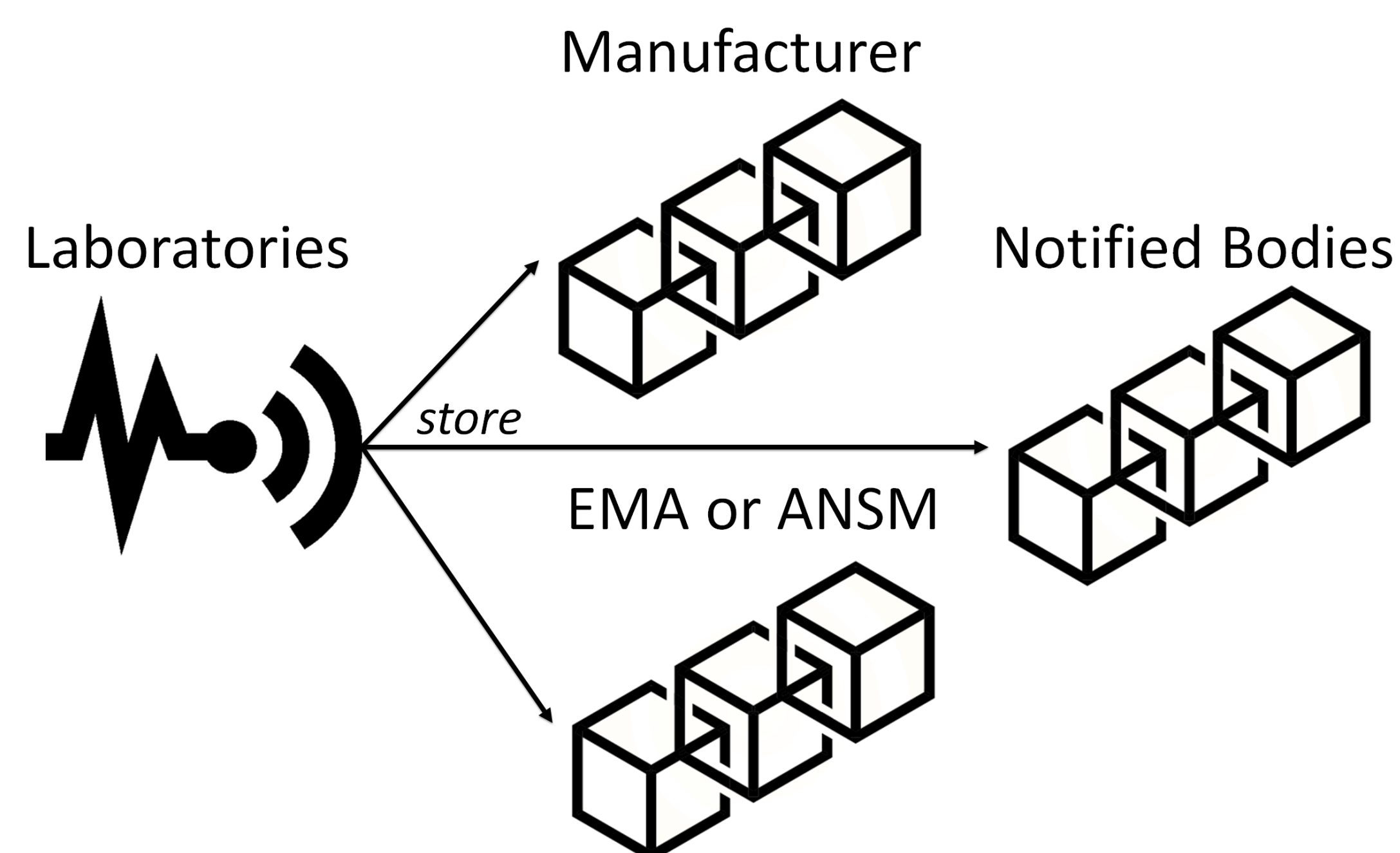


Fig.1: Study environment

Blockchain

Blockchain is an open, distributed public ledger storing all transactions in a secure and verifiable way. It works as a huge, secure and decentralized data-store. Each transaction is placed into a block of the chain, which is linked to the previous block, ensuring **data immutability**, as seen in Fig 2. A Blockchain is replicated across a number of nodes, which can also act as validators for pending blocks. This replication means that it takes time to reach the farthest nodes, thus making Blockchain extremely **good for maintaining data integrity**, but **less suitable for big data storing**.

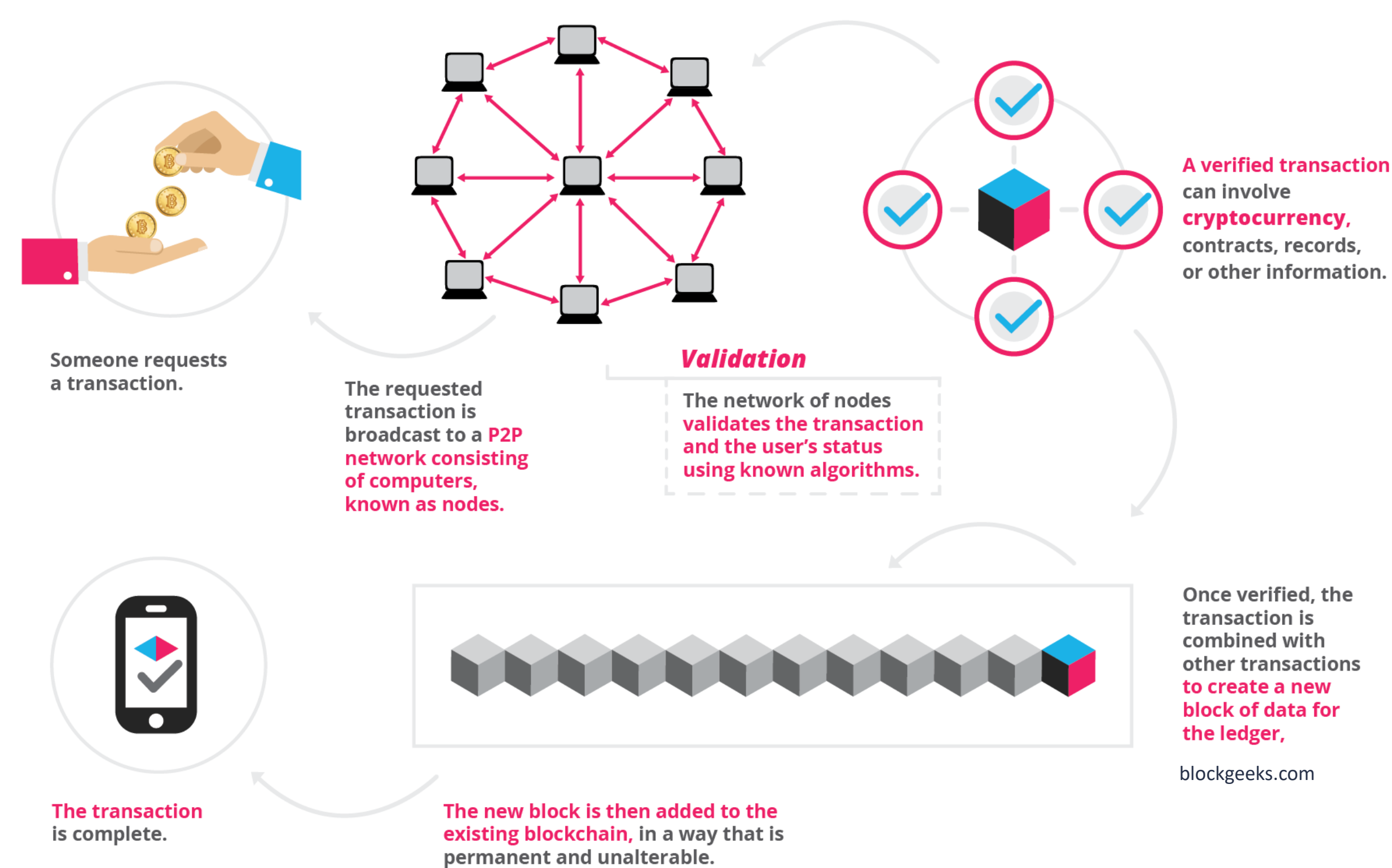


Fig.2: How a typical Blockchain works

Quality by Design

Quality by Design is a risk-based approach made to **lower the risks of failure** (being out-of-specifications) by using statistical modeling methods. It works as a continuous improvement method, as seen in Fig. 3. QbD can help to develop an adequate Blockchain solution, through the design of experiments and the estimation of critical event probabilities, that will respect pharmaceutical industry's standard of data integrity **without sacrificing too much in terms of performance** that Blockchains could lack with its generic implementation.



Fig.3: Quality by Design life cycle

Method

We'll **adapt** and apply the Quality by Design methodology to the creation of a Blockchain solution that must comply to **specifications**. Blockchain is a relatively new technology with few works on its **performances** or its **fine-tuning** in regards of **big data**. To begin, after the study of numerous papers, **critical quality attribute (CQA) were defined** as seen in Fig. 4. The next step is to use a Blockchain model described by Petri networks to **identify critical structural parameters** of the Blockchain when handling **big data flows**. A **design space** will then be created which will provide a **top-down and multivariate view** of the process, allowing to make changes to **maintain optimal quality**.

Specification	CQA
Quality of Experience	Transaction throughput
	Mean validation throughput
Integrity	Mathematical proof
Quality of Service	Validation latency
Costs (€, energy)	Server hardware, sensors, kWh, etc

Fig.4: Critical quality attributes : property or characteristics that should remain within a certain range