A NEW PARADIGM FOR MONITORING THE QUALITY OF A PROCESS IN AVIATION INDUSTRY - DECENTRALIZED APPLICATIONS IN BLOCKCHAIN

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Abstract: *We are living in a digitalization age, in which software and smart devices are leading all industries. In this context, the traditional supply chain approach and the current maintenance and operations tracking systems need to be changed, in order to face the challenges of the new digital world. The purpose of this study was to design an innovative method by which a traditional web application can be integrated in a blockchain environment. Two use cases from aviation industry were studied - ensuring aircraft maintenance traceability and aircraft components supply chain. These reasons motivate us to create a possible workflow of a decentralized blockchain-based application. The era of Big Data and digitalization implies a different approach where decentralized apps will be part of the new revolution. Business owners who will embrace this methodology, of certifying data in a transparent, auditable and immutable peer to peer network, will fuel the level of quality assurance of the products and services offered to their customers. The proposed methodology opens many doors for entrepreneurs who want to add a new layer of transparency to their business processes, in the benefit of their customers.*

Key words: *Blockchain, Aviation maintenance, Supply chain, Big Data, Digitalization*

1. INTRODUCTION

We are living in a timeframe where almost everything happens digitally, a situation that the world has never met before. It basically outlines an intangible digital world with a direct impact on our real tangible world. We have reached a point where there is no business entity without activity in the digital environment.

A famous whitepaper in the blockchain technology space, called "Bitcoin: A Peer-To-Peer Electronic Cash System"[1], propose a disruptive technology of exchanging values in a Peer-to-peer ecosystem. The study reveals a different approach of sending value without involving a third party, in a secure and a transparent way. Given the downsides of the centralized databases in some specific applications like supply chain or aircraft

maintenance traceability, we can state that blockchain technology will improve the financial system, supply chain and any industry where data authenticity is needed. Moreover, we are witnessing a big data revolution from which we deduce an exponential increase in the need of trust and integrity in the data management. Even if we are referring to a data supply chain or to records of a million-dollar aircraft we need trust and transparency.

The concept of a Peer-To-Peer network was upgraded by the founders of Ethereum, who came out with new features in the blockchain space: smart contracts and decentralized applications. According to the Ethereum whitepaper [2] they created a complex blockchain network capable of storing not only simple transactions but also pieces of codes, called "smart-contracts" responsible of running

different types of applications. Going further through scientific literature we found out another interesting concept called Inter Planetary Files System (IPFS). Globally used, the IPFS is a distributed database for large amounts of data. The blockchain Peer-To-Peer was not designed to store large amounts of data, instead is used like a transaction ledger. Combined with IPFS can solve the limitation of quantity. [3]

A notable review of the literature for blockchain application in supply chain was conducted in 2020 that pointed out a promising future of blockchain technology in many business cases, like supply chain distribution. [4]

From the aviation perspective, recent studies have shown that blockchain technology will have a big impact within the following years in the operations, maintenance and Identity Management [5]

Summing up all concepts presented above we designed a possible workflow for a decentralized application.

Digitization in general implies an exponential growth of data and probably here appears the real technological revolution, in the way we manipulate data in a digital infrastructure.

The main players in the 21st century that have the major dominance throughout the internet, the well-known technology giants have amazing collections of data about their users. Currently, in the online environment, any transaction or exchange of information is done through a third party. Thus, it turns out that a large part of the internet is controlled by only a few players, which makes it somewhat vulnerable to failures and unexpected exploits.

2. BLOCKCHAIN, A SAFE AND RELIABLE ECOSYSTEM

In essence, the blockchain is a database or register in which user data is stored, but also all operations that take place between users. As the name suggests, blockchain is a peer-to-peer network made up of a series of virtual blocks with a unique identity, called a hash. Within the chain, each block contains information about the hash of the previous block, up to the original block of the string (also called genesis block).

But a blockchain is also an open ledger, which means that it can be accessed by any user around the ecosystem with a computer and an internet connection.

But another reason why blockchain technology gets so much attention is that these blocks can store virtually any type of data. This means that in addition to creating virtual currencies, blockchain technology can have many other uses in everyday life.

Another term that makes this technology so interesting is the notion of "smart contracts". These are basically blockchain programs, similar with paper contracts. A smart contract can be programmed so that an operation / clause is executed automatically when certain conditions are met. Being created exclusively in the blockchain, they cannot be modified once they are created.

Therefore, a blockchain is a digital ecosystem distributed throughout a network at an internet scale, governed by standardized rules, extremely safe and impossible to be hacked [6].

Overall, the Internet has made possible a number of positive changes since the early 1990s. The evolution of the Internet in terms of speed, bandwidth and accessibility has made it possible to develop applications that no one thought would be possible: ecommerce, online streaming etc.

Similarly, the current development of a secure, peer-to-peer and very fast ecosystem will lay the foundations for decentralized applications where the need for trust and uniqueness is urgently needed. Whether we are talking about financial applications or in the supply chain area, they will all be based on the same principle of operation.
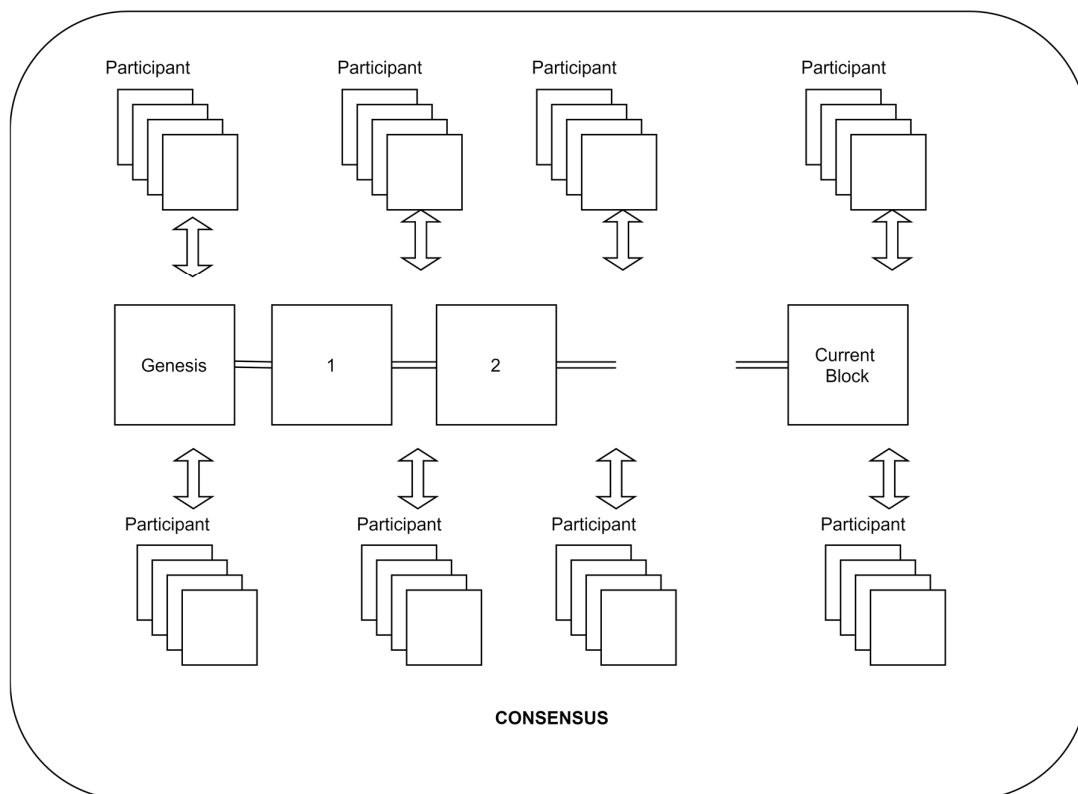
Fig. 1. The overall workflow of a blockchain infrastructure

3. DECENTRALIZED APPS WITHIN AEROSPACE INDUSTRY

The advent of blockchain decentralized technology has not only paved the way for cryptocurrencies and smart contracts, but also for a new generation of computer programs / applications known as decentralized applications or "DApps". The code of these programs is not stored on central servers, but - as the name implies - in a decentralized, peer-to-peer network, without a central node. Decentralized open-source programs are guaranteed to run exactly as they are written, because no entity controls them. The changes are made in a consensus between users and the developer, a DApp runs autonomously and the data cannot be altered.

This means that DApps applications offer a level of protection against interference that similar centralized applications cannot provide, because in the case of the former, there is no central server that can be attacked in any way. As a result, decentralized applications are much more secure and not vulnerable to attacks.

3.1. Aircraft maintenance traceability

Decentralized applications are not useful in any situation, but if we refer to the aeronautical industry, here there are certain areas where the blockchain can really bring added value [7]. For instance, ensuring the quality and periodicity of preventive maintenance tasks is essential for maintaining the airworthiness of a fleet. Just as for a person the correctness of a medical history can make the difference between life and death, so the history of operation and applied maintenance for a component of an aircraft can make the difference between life and death for people traveling with that aircraft. A modern aircraft can have up to several thousand components, some of which are interoperable, on which technicians periodically intervene to perform routine inspections. At the same time, the aircraft itself has a multitude of periodic maintenance tasks in accordance with the manufacturer's regulations.

All these operations that are performed periodically at an aircraft reflect operator compliance with the regulators, the aircraft technical condition and the evolution of an

aircraft. In a word, this operating history reflects the quality of an aircraft. Having a clear image of the quality of an aircraft can also assess the level of safety it offers for the passengers.

Today, in a centralized regime, technicians record any action on an aircraft in documents called "forms" that are at best deployed in digital format in a database managed by a third party contracted by the aircraft operator [8]. Unfortunately, in many cases this information remains on paper. This data is extremely sensitive because it can reflect the safety of the way millions of passengers are transported. In the event of a plane crash, the authorities immediately collect this data to identify the causes. The recording and manipulation of this data in a digital format is not standardized and is not done automatically based on a consensus protocol, as it happens in the blockchain. The level of complexity of these data is extremely high, due to the following aspects:

1. The number of aircraft has experienced an accelerated growth in recent years, simultaneously with their level of technology, resulting in some state-of-the-art aircraft, generating data capable of making flights almost autonomously. This expansion, both qualitative and quantitative, forces us to identify new methods of managing the resulting data, in a standardized and secure digital ecosystem, totally different from traditional approaches;

2. On the other hand, the complexity results from the fact that the air operators have facilities spread all over the globe and collaborate with third parties to carry out the technical operations. The big picture can be summarized as that: Many entities involved from different locations that although operating on the basis of well-established regulations do not have a common protocol for digital management of maintenance records. We, the passengers, must blindly believe that the air operators have maintained the aircraft in accordance with the regulations in force;

The purpose of this study is to validate the idea that technology itself can autonomously manage this data. The benefits can be major, in addition to the trust that this system would bring in the eyes of passengers, aeronautical authorities or shareholders, data storage under a common standardized protocol and recognized

by specialists in the field opens new opportunities for big data analysis.

3.2. Supply chain in aerospace industry

Ensuring traceability and efficient in the supply chain sector enable companies to accomplish their financial purposes. Moreover, this principle is applicable in globally interconnected industry like aerospace where quality, efficiency and product conformity is a priority for any participant involved.

Today, supply chains are comprised of complex system with many parties involves, spread all over the world. From original equipment manufacturer to the end customer products record a significant quantity of data.

The traditional supply system fails to provide sufficient, accurate and real-time data on what happens to an asset, which is necessary for entities that do not trust each other regarding a particular product, its price, delivery conditions and so on and so forth. The information is not always updated from some participants and some data may be hidden.

All parties involved in the supply chain should be able to track a product in real time. For this scenario to be possible, a high band, secure and fast digital infrastructure is needed to be ruled by consensus protocol.

Another benefit for aviation industry, resulted from implementing a consensus protocol within a distributed network like blockchain, is that all players involved will be able to sell and buy products with the confidence that the goods they trade are in accordance with the applicable regulations.

3.3. Interacting with a blockchain protocol through a decentralized application

Given the statements presented above, the study continues with the assumption that all network participants agree on how data is validated, stored and transferred.

Even if blockchain seems to be a technology that is being implemented faster than anticipated, it can only bring value if there is consensus around a distributed platform. For this consensus and adoption to happen,

it is necessary for the participants to fully understand the added value and develop some real use cases.

Given both the complexity and the early stages of the blockchain technology, this study proposes a hybrid approach for developing a theoretical workflow of a web application designed to run in blockchain ecosystem. The structure of this application can be applied in any field where the traceability of processes is important and must be monitored. The concept can be adapted depending on the type and operational needs.

Normally, when a web application is accessed, the user is connecting to web server using a web browser. The server contains all the code, one the one hand it hosts all the client-side files like Html, CSS and JavaScript. On the other hand, the central server also contains all the backend logic resources and a traditional database [9].
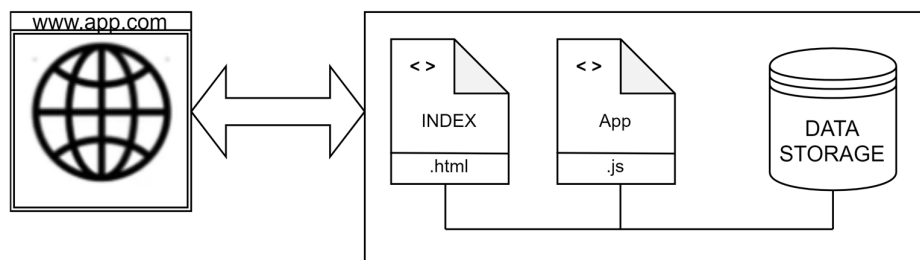

Fig. 2. Traditional web application workflow [9]

Theoretically, in case of a decentralized application (DApp) things are working differently because instead of connecting directly to a server, it will connect to a blockchain network [10]. However, for the reasons presented above, this study proposes a hybrid application that uses both traditional databases and blockchain.

First of all, a blockchain-based application needs a gateway for authentication to interact with the blockchain. Basically, it is a tool, often installed in the browser, which fulfils the functions of authentication, account management and signing transactions. In the crypto space it is also called as a "wallet" [11]. The interaction between blockchain and authentication tool(wallet) is realized through a blockchain as a service provider, which is hosting a blockchain node and open a RESTful API for the wallet to connect. As for any other wallet, for each account, an address, a public and a private key is associated.

Once, the authorization is in place the workflow continues with the client-side application in browser through which the data is send to the server, packed in a json file. In a

development environment for smart contracts like Remix or Truffle for Ethereum protocol, a contract is created using solidity programming language. It is compiled and transformed in BYCODE and ABI. Further, the contract is deployed in the blockchain and its address is returned in order to have a hook through which the contract will be called.

In the backend, the process continues with a series of logic operations specific to the application functionality.

After the data has been sent from the client side, this study proposes two options to continues the process.

First, in the backend server, the data is converted to a hexadecimal code using an irreversible hash function and send it to the blockchain. In addition to a unique address, the created smart contract has a series of predefined and ready to be called functions(methods). Therefore, the hash number previously created will be sent to the smart contract together with the name of the function to be called through a JSON RCP protocol. In layman's terms, we send data to a smart contract and tell it what to do with it in a relation to the blockchain (read, add, create).

Interacting with a blockchain protocol through a DApp
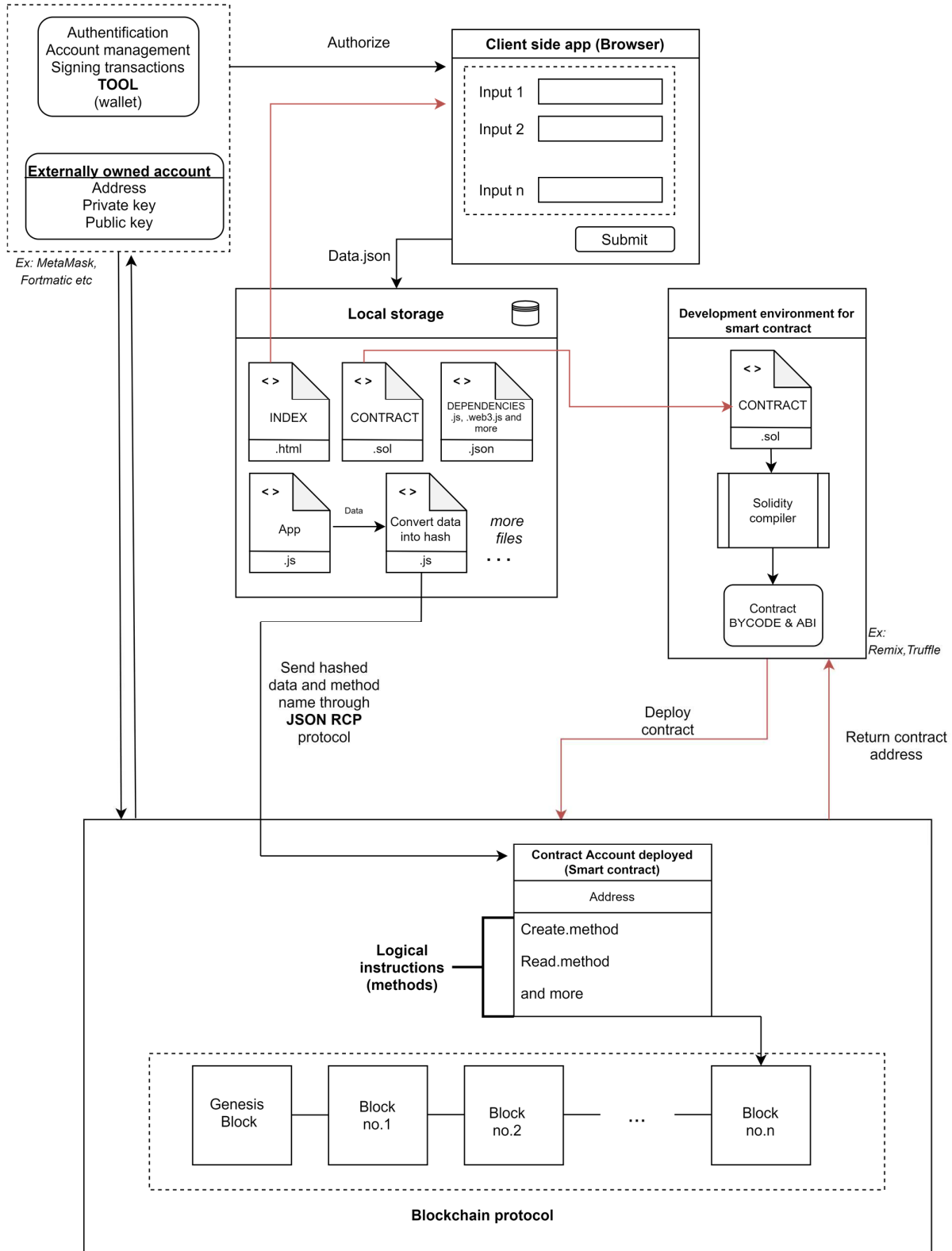

Fig. 3. The proposed data workflow for a decentralized application

The unprocessed data will be also stored exactly as it was sent from the browser to a traditional database on the server. The idea, here is that every set of record data has a corresponding hash in the blockchain, thus the authenticity of the data can be easily verified. The downside of this method is that the data can be altered on the traditional server. However, this method provides a proof of authenticity and involves a fast and small quantity of data to be stored in blockchain. The workflow is presented in the figure 3.

The other option involves storing the entire data into a distributed database called "Inter Planetary File System" (IPFS) with a corresponding hash in a blockchain protocol. However, depending on the operational requirements, the data can be encrypted if they are registered in a public blockchain and a certain level of confidentiality is desired.

4. CONCLUSIONS

Blockchain technology and decentralized applications will impact most industries because digitization involves data that must be managed in a secure and transparent manner.

In an ecosystem where all members are in consensus with certain rules, blockchain technology can bring more transparency and security.

The democratization of the Internet and the protection of individual data are becoming a necessity for the new generations in the foreseeable future. The centralized way in which the internet currently operates facilitates the deletion or modification of certain data according to the interest of certain entities. In this form of today's internet, certain data exchanges cannot be made in conditions of maximum transparency.

In order to remain competitive in a digital world, companies must embrace new technologies and tools that bring more transparency for their customers. Blockchain and DApps could be a solution.

5. ACKNOWLEDGEMENTS

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O NOUĂ PARADIGMĂ PENTRU MONITORIZAREA CALITĂȚII UNUI PROCES ÎN INDUSTRIA AVIATICĂ - APLICAȚII DESCENTRALIZATE ÎN BLOCKCHAIN

Rezumat: Trăim într-o era digitalizării, în care software-ul și dispozitivele inteligente sunt lideri în toate industriile. În acest context, abordarea tradițională a lanțului de aprovizionare și sistemele actuale de întreținere și urmărire a operațiunilor trebuie schimbate, pentru a face față provocărilor noii lumi digitale. Scopul acestui studiu a fost de a proiecta o metodă inovatoare prin care o aplicație web tradițională poate fi integrată într-un mediu blockchain. Au fost studiate două cazuri de utilizare din industria aviației - asigurarea trasabilității întreținerii aeronavelor și lanțul de aprovizionare a componentelor aeronavelor. Aceste rațiuni ne motivează să creăm un posibil flux de lucru al unei aplicații descentralizate bazate pe blockchain. Era Big Data și digitalizarea implică o abordare diferită în care aplicațiile descentralizate vor face parte din noua revoluție. Proprietarii de afaceri care vor îmbrățișa această metodologie, de certificare a datelor într-o rețea peer to peer transparentă, auditabilă și imuabilă, vor alimenta nivelul de asigurare a calității produselor și serviciilor oferite clienților lor. Metodologia propusă deschide multe uși pentru antreprenorii care doresc să adauge un nou strat de transparență proceselor lor de afaceri, în beneficiul clienților lor.

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