Tokenized Hardware: The New Crypto Innovation

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February 2, 2018

Abstract. There are various types of tokens currently existing in the cryptocurrency economic, such as utility token, security token, and coins. The SEC recently announced to consider Initial Coin Offering (ICO) as securities which could be a good thing since the ICOs as securities is a new viable way to raise funds, called tokenized securities. In this paper, we propose the tokenized hardware, another new viable way to hardware manufacturing and production for open hardware economic. Tokenized hardware can ensure the assets of the hardware rights, data privacy, and data security by hardware tokens. Accordingly, we also propose the concept of Initial Mining Offering (IMO) to generate such hardware tokens in-place, this way, the tokens will be pre-mined for a few amount of tokens which need to be agreed by the tokenized hardware ecosystem including manufacturers, developers, and consumers. We consider that the tokenized hardware technology will represent a revolutionary innovation to build more trust and secure hardware.

Keywords: Token, Blockchain, Cryptocurrency, Tokenzied Hardware

1. Introduction

In recent years, the *crypto* has become an emerging technology for creating more secure and decentralized systems. Ethereum platform, an Ethash-based blockchain system, uses such technology to issue *tokens*, which can be utilized as *cryptocurrency* that can be traded in any central exchange. Accordingly, startups can also raise funds by selling virtual shares in the form of security tokens, called tokenized security. As such, this paper proposes the tokenized hardware, a new idea for current crypto economic.

Figure 1 shows that hardware has to undergo a phase of the invention, and this paper proposes that we are currently in the early stage of evolution of new technology, called tokenized hardware. The blockchain technology represents an innovation that enables secure communications of parties over a trusted network,

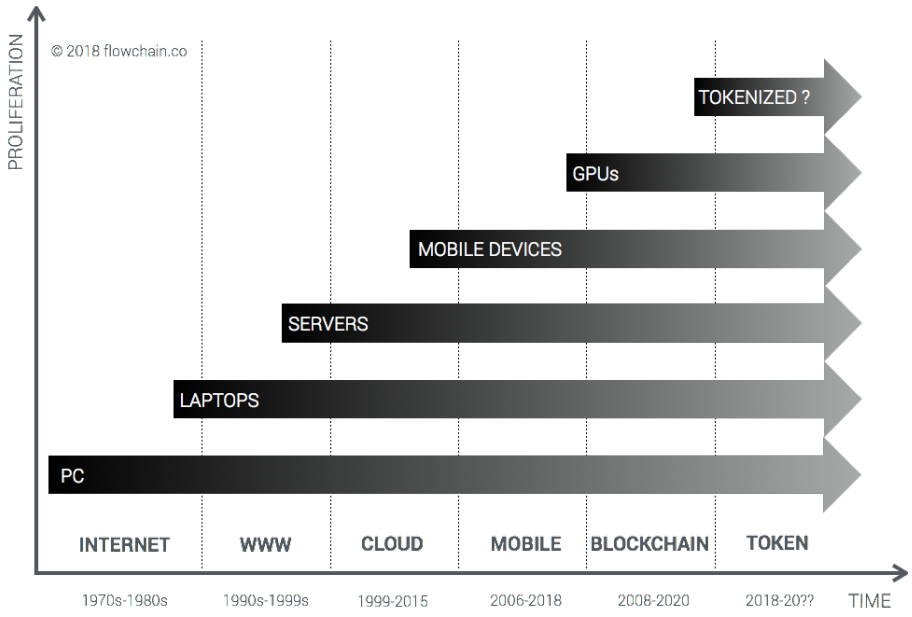

Fig. 1. Tokenized Hardware Proliferation

and notable benefits around tokenized hardware are that it can ensure the data trust, privacy, and open new business opportunities for manufacturers.

Nevertheless, tokenized hardware can gain viable benefits such as security, privacy, and decentralization by associating tokens to hardware devices and based on a blockchain technology. Therefore, this position paper will introduce the change and benefits from traditional hardware economic to tokenized hardware economic. The tokens are secure values which can be used as a utility hash to access services. Also, tokens are consensus via *mining* in which the cryptographic systems are used to generate such hash values. The hash values, called utility tokens, are compared to API keys. Nevertheless, in today's cryptocurrency economics, the hash values are also used as *security tokens* to raise funds.

2. Tokenized Hardware

It's the token fundamentals to define the benefits the customers gain from holding tokens, thus, linking viable benefits with token usage models is a critical issue in our research. By reviewing some fundamentals related to tokens, we propose the IMO model to address this issue. The tokens mined by the IMO model, called utility tokens, are highly scarce and not for commercial use. The benefits customers gain from utility tokens are as the following examples.

1. Access the basic cloud service
2. After-sales service
3. Purchase discount

The amount of total supply of utility tokens equals to the total quantity of each shipment, and utility tokens must record their *benefits* provided on public blockchains, such as Ethereum and Hyperledger. As such, this paper will also propose Dextoken, a public blockchain, for this purpose. In short, utility tokens can grant permissions to authorized hardware for accessing cloud service, request for the after-sales service, and other available benefits provided by hardware manufacturers. Also, unlike public blockchains, private blockchains are permissioned blockchains that are controlled by their operators, and only grant permissions to authorized users [1]; thus, each shipment of the hardware can be employed as a *private blockchain* by which utility tokens are mined.

Moreover, *maker* is a cultural phenomenon in the open hardware industry. Internet of Things (IoT) is a connected device enables the sensory data transfers to the Internet, and applications can participate the IoT device to access these sensory data. For participating the IoT device, the participants have to pay the device for data access. Unlike utility tokens, the payment is in cryptocurrencies, such as Bitcoin and ERC20 currencies, which uses encryption techniques to regulate the generation units of the cryptocurrency and verify the transaction of funds. Moreover, unlike fiat currencies, cryptocurrencies are usually operating independently without a central bank and can be minted on public blockchains, such as Ethereum. In conclusion, the payment of funds is achieved with cryptocurrencies in a peer-to-peer (P2P) manner, called client-to-client (C2C) model. To support the p2p model, this paper offers Dextoken, an Ethash-based token, for such payments.

3. Assets

Assets can be tangible or intangible and represent the value of ownership to produce value [2] which can be converted into cash. Also, digital assets exist in the form of binary data; however, the ownership of digital assets sometimes is hard to determine. For example, the data do not possess the right to use are not regarded digital assets. And this problem usually arises in the hardware industry. Furthermore, the tokenized hardware we proposed in this paper can resolve such problem. Accordingly, figure 1 shows the differences between hardware and tokenized hardware.

- Tangible assets. The physical materials include PCBA, chipsets, sensors, etc.
- Digital assets. The data produced by hardware.

In summary, tokenized hardware comprises of tangible and digital assets, and compare to traditional hardware, and the tokenized hardware can ensure the benefits.

– Ownership and rights. We use the Dextoken platform to ensure the ownership of tangible assets, and possess the right to use the digital assets.
– Depreciation. We use the *coin age* technique to calculate the depreciation of the hardware.
– Externality. The *externality* is the benefit of a consequence of an economic activity experienced by unrelated third parties, such as the value increment by celebrity effect. The externality can be either positive or negative, and mainly affected by a party.

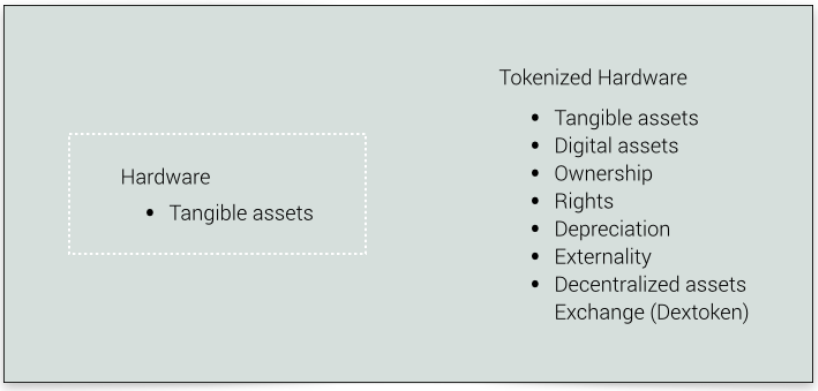

Fig. 2. The Tokenized Hardware

These benefits come from using the utility tokens previously described, and utility tokens are generating with the IMO model. The tokens are publicly accessible via the Dextoken platform, and the platform can provide extra information about the tokenized hardware, such as manufacturing date and product model. Therefore, the Dextoken can also replace the traditional hardware labels.

Furthermore, in the tokenized hardware industry, one of the most visible impacts is that the hardware company has to provide an incentive design. A favorable incentive design can help to build a sustainable blockchain network and keep the network healthy, meaning that the incentive can encourage participants to support the company by participating in the business activities of the company.

4. The Blockchain Technology

Technically, the success of tokenized hardware should attribute the device interoperability and a peer-to-peer network; thus, we have already developed Flowchain

[3], the blockchain for the IoT, to practically prove the concept of this work. The previous work has already attempted to build a generic software framework for tokenized hardware and decentralized IoT applications.

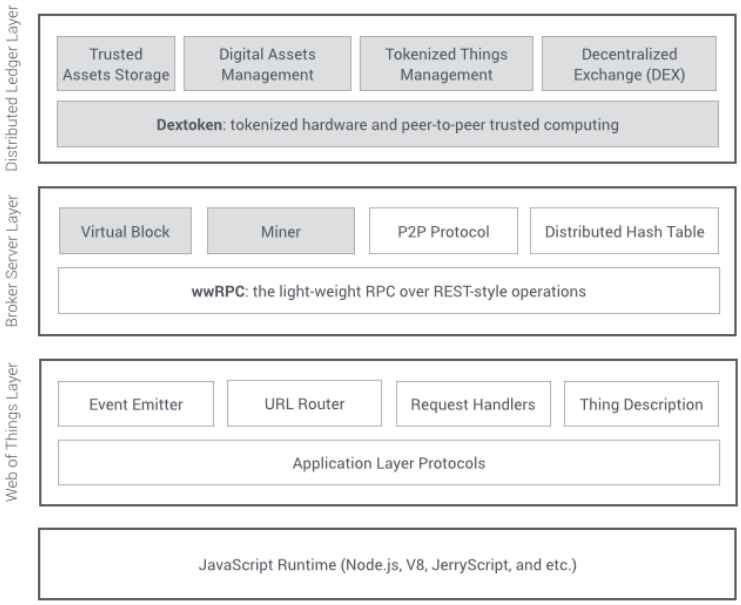

Fig. 3. The Flowchain Software Framework

This paper will use Flowchain, the previous work of this paper, to build a Trusted Assets Storage (TAS). TAS is the local storage to store the trusted transaction objects. As such, the transactional data stored in the local storage can be regarded trusted. Accordingly, the hardware has to mine blocks to grow the size of its object storage. Technically, TAS is decentralized file storage, and hardware can expand the storage size by mining more blocks. The WiFi camera is a use case among tokenized hardware products. The WiFi camera is a tangible asset while the video streams produced by the camera are digital assets, in short, the tokenized camera is an asset comprised of the hardware asset and the digital assets, and the token holder has the rights to use these assets. Subsequently, the blockchain can issue access tokens to users who want to access the digital data from the camera. As such, there is a use scenario of such tokenized camera hardware.

1. John has an app on his mobile phone
2. An app pays some units to the WiFi camera
3. The blockchain issues an access token to mobile apps after verifying the transactions

4. The app starts with received video streams, the digital assets of the tokenized hardware
5. John can watch the video from the camera

Such use scenario is a use case of tokenized hardware proposed by this paper; nevertheless, we define connected tokenized hardware as *Tokenized Things* compare to the classical Internet of Things (IoT). Also, technically, a tokenized thing has to be represented as *Virtual Things* with the ontology of Web of Things (WoT) and operates in a p2p manner. Therefore, this paper has also developed the *Devify* software framework [4], a generic and comprehensive software framework based on Flowchain for building p2p IoT networks.

5. Decentralized Exchange

This paper proposes Dextoken, the Decentralized EXchange tokens, for tokenized hardware to exchange digital assets over p2p networks. Notably, digital assets require clients to pay for access them; thus Dextoken can also be applied as an alternative cryptocurrency, or *altcoin*, that miners and tokenized hardware can sell Dextoken on any existing cryptocurrency exchange. Accordingly, the Dextoken network relies on volunteer miners for relaying digital assets with encryption techniques to verify the transactions, the payment for accessing digital assets, thus, the miners will be rewarded by a fixed amount of units of Dextoken by supporting the Dextoken network.

Furthermore, the cryptocurrency holders can sell them on any existing centralized exchange; thus, they are recognized as *crypto assets*. Therefore, the tokenized hardware can also exchange Dextoken with any existing cryptocurrency. In short, tokenized hardware can be simply employed as hardware wallets which can store digital assets and crypto assets, such as cryptocurrencies.

6. Key Challenges

This paper has depicted a conceptual framework of a tokenized hardware system and the viable benefits for consumers and the community; however, Seeed Studio, the lead open hardware manufacturer, has shown through the experiences that there exist some challenges in current hardware industries.

– Manufacturing costs. The ecosystem may benefit the consumer and the community a lot. However, it may increase the cost to manufacture tokenized hardware. The extra increased costs mainly come from the operations fee of blockchain systems.

– Scarce. This paper has already depicted the IMO idea to generate highly scarce tokens to achieve a solid incentive. However, instead of manufacturers, can the crypto community mine utility tokens is an issue.

There are still fundamental challenges before we can build a health tokenized hardware ecosystem.

7. Conclusion

To address issues of the fundamental challenges and to build a sustainable tokenized ecosystem, this paper is constructing a *testnet* for future evaluation on how to face and solve these challenges. Therefore, we would like to call for participants who wish to join our work for the next big thing of the hardware industry, https://flowchain.co

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