Review of research on blockchain application development method

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Abstract. The blockchain technology is complex and involves a wide range of fields, which leads to the lack of uniform specifications for the development of blockchain applications. Although blockchain used to be divided according to the decentralized degree by some organizations, which are difficult to give developers specific guidance and results. To this end, this paper proposed a feature-oriented classification method of blockchain applications based on the analysis and comparison of current typical blockchain applications and frameworks, including digital currency blockchain, development platform blockchain, decentralized application and extended blockchain, helping developer create blockchain applications of a targeted manner and clarifying the functional architecture of different types of above various blockchain applications. Finally, the above classification method has been verified by the analysis of an extended blockchain.

1. Introduction
Blockchain is an innovative application model of computer technology in the era of Internet in distributed storage, point-to-point transmission, consensus mechanism and encryption algorithm[1]. As a distributed "ledger" with decentralized, immutable and transparent features, blockchain has captured world’s attention. China Blockchain Industry Conference was held in Beijing with a series of related policies formulated on August 21, 2016[2]. Two months later, the Ministry of Industry and Information Technology released the white paper about blockchain technology in china at the first time[3].

The development of blockchain technology has not only brought blockchain applications into digital currency, but also in the fields of credit, energy, logistics, finance and so forth. As a complex network-based software connector, blockchain has many components and configurations, in which its internal structure will lead to some changes[4]. Up to now, the academia still lacks a unified standard for the classification of blockchain applications, and most of the known blockchain classification methods are based on the level of conceptual or logic, lacking comparison of specific functions. Ingo Weber classified the architecture of the blockchain according to the quality and performance of the blockchain system[5]. Blockchain were divided into two dimensions by Hitoshi Okada based on whether there exists on market incentives and authority control[6]. This paper investigated several mainstream blockchains in the market, and then a classification method based on the functional feature of blockchain was proposed which divided the blockchain applications into digital currency, development platform, decentralized application(DAPP) and extension class.
The next of paper is arranged as following: The second section mainly introduces the architecture of the mainstream blockchains. The third section comes up with a feature-oriented classification method for blockchain development. The last section verifies the above classification method with a specific application example.

2. Application architecture of Blockchain
Blockchain applications are widely used for which different features is not the same. The article will introduce architectures of several typical blockchain applications.

2.1. Bitcoin
Bitcoin has the most basic blockchain architecture whose structure is shown in Figure 1. The infrastructure layer is mainly used to implement data storage, transaction transmit and network security. The kernel layer includes POW(Proof of Work) consensus, transaction scripts, token rewards, mining and information verification\(^7\). They can support efficient transactions, token release and data consistency between nodes. The basic function of Bitcoin is to realize the decentralized transaction of currency, so the scope of application is relatively limited. Also, users can manage their accounts and view transaction information in real time through client wallet.

2.2. Ethereum
The basic layer of Ethereum is similar to Bitcoin, but the core layers are much different. The architecture of Ethereum is shown in Figure 2. The transaction in Ethereum is essentially a process of state transition. The user can trade through the account or trigger the relevant smart contract, then the miner will pack the block to the chain after verifying the transaction information. The event helps the client read the smart contract and store the contract information. Of course, the EVM (Ethereum Virtual Machine) is the core component of Ethereum\(^8\). Since EVM is Turing-Complete, developers can use high-level languages to compile complex operations such as solidity.

2.3. Beihang Chain
Beihang Chain is the representative of applied blockchain, and the functional architecture of that is shown in Figure 3. The chain aims at scalability, introducing double-chain services based on the common blockchain platform. ABC (account chain) creates account indexes to speed up the query rate, and TBC (transaction chain) aims at chain transactions. The consensus agreement adopts Byzantine voting in which the master node elected by the duplicate node can verify and submit, improving the blockchain transaction rate greatly\(^9\).

The architecture of typical blockchain application has limitations and is relative to specific products. To this end, many organizations began to develop uniform development standards for blockchain applications. The Ministry of Industry and Information Technology issued “The Functional Architecture of Blockchain”\(^10\) in May 2017 (Figure 4). It depicts the abstraction of technical details in...
blockchain, but it ignores the diversity of blockchain applications and does not describe the characteristics of blockchain application.

3. **Feature-oriented classification method for blockchain applications**

It is essential to understand the type of blockchain in the development of blockchain applications. The mainstream classification idea is to divide the blockchain into public chain, consortium chain and private chain according to the degree of participation of nodes. That mainstream method neglects the connection between different blockchains and its own functional characteristics. Therefore, we propose a feature-oriented classification method for blockchain applications after analyzing the functional characteristics of typical blockchain. The classification principle is shown in Table 1:

| Only Involves Upper Interface | Only Currency Function | Smart Contract | Cross-Chain |
|------------------------------|------------------------|----------------|-------------|
| **Digital currency**         | no                     | yes            | no          | no          |
| **Development platform**     | no                     | no             | yes         | no          |
| **Decentralized application**| yes                    | no             | yes         | no          |
| **Extended blockchain**      | no                     | no             | yes         | yes         |

3.1. **Digital currency blockchain**

Digital currency blockchain aims at creating a digital currency that can achieve value storage, transfer, and liquidation. The best-known blockchain representative is Bitcoin. According to the functional characteristics of the digital currency blockchain, its structure can be summarized as shown in Figure 5.

The infrastructure layer includes block structure, hash algorithms and P2P Network. The block data is used to store the users’ transaction information, and the hash algorithms can solve anonymity and the lightweight storage of information. P2P Network ensures the distributed characteristics of the system. The kernel layer includes consensus algorithms, encryption, digital signature, timestamps and script. Among them, the guarantee of data consistency is provided by consensus algorithms, and digital signature make transaction more secure and reliable. In addition, time stamp record when the block is created, and the script defines the rule of transaction. The application layer includes trading websites, wallets and API, which can provide user-friendly interface.
3.2. Development platform blockchain

The development platform blockchain mainly provides developers with a platform to develop decentralized applications rapidly. Its application architecture is shown in Figure 6. The infrastructure layer is similar to the digital currency blockchain, providing core technical support for the upper layer. The kernel layer adds smart contracts and virtual machine technology. Among them, smart contracts can accept and store the value, and virtual machines are the basic components on which high-level languages written by developers need to be compiled and executed. The service layer helps the blockchain platform to provide management services, including user node access, third-party extension development and node authority management. The application layer focus on the interaction with developers such as DAPP.

3.3. Decentralized application

Decentralized application (DAPP) is a distributed application running on a blockchain platform. It has the following characteristics: running on a distributed network, storing information safely, and greatly protecting privacy. Similar to mobile apps, decentralized applications usually contain a user-friendly interface. The difference is that they are decentralized, and data is immutable. The functional structure of the decentralized application is shown in Figure 7. The application layer only provides user registration, transaction, query and other normal function. The core layer consists of smart contracts written by developers.
3.4. Extended blockchain

There are remarkable functions in extended blockchain of which the core layer incorporates many supererogatory technologies including sharding network, multi-channel technologies and block expansion, helping to greatly improve transaction speed and throughput. For example, the extended blockchain ZEPPELIN used sharding techniques to increase the throughput of blockchain up to million-second transaction speeds\cite{11}. The extended layer introduces new technologies such as cross-chain technology, contract extension, and chain-chain to improve system performance and help implement the practical of blockchain. For example, Plasma autonomously expands smart contracts to improve system robustness\cite{12}. Fabric Token adds multi-chain structure to support high-performance smart contract interaction\cite{13}. The architecture of extended application is shown as Figure 8.

4. Analysis of blockchain application

This paper takes the P2P trading system on the Power Ledger platform as an example to analyze how to develop blockchain applications.

First, we have analysis of the P2P trading system to reveals three roles in the power trading system: consumers, producers and holders. Among them, consumers corresponding with individual users purely need electric energy, and producers produce renewable energy (such as solar energy) by themselves and can trade electrical energy with other consumers through blockchain technology. The holders are responsible for purchasing the POWR token and redeem it to a Spakz token for distributing\cite{14}.

According to the user role, we can initially summarize the functions of the system including as follows:

- Rely on smart contracts to control user transactions and currency exchange.
- Provide smart meters to protect users' power information at any time.
- Double-chain structure for cross-regional token clearing.
- Control node permissions to implement user access management.

Based on our analysis, the extended blockchain is selected as the architecture prototype. The functional structure of Power Ledger as shown in Figure 9.

![Figure 9. The structure of Power Ledger](image)

The infrastructure layer design is similar to Ethereum, and the difference is that the system uses oracle to store data for data management in order to effectively store transaction history information. The kernel layer uses POS as consensus protocol to minimize the consumption of internal resource. In addition, Power Ledger uses the self-developed EcoChainTM (EcoChain) as the upper blockchain to form a double-chain structure.

The service layer is mainly provided by EcoChain Service and mainly includes the following components: token exchanging, smart bond, token hosting pool and node authority management. The token exchanging provides exchange of Sparkz tokens and POWR tokens. Sparkz is a medium for maintaining exchange rates between tokens and local currencies. Smart Bonds ensure that transactions...
between users are carried out efficiently, otherwise the POWR tokens are blocked. The token hosting pool hosts the tokens of the power beneficiaries and provides the user with token rewards.

5. Summary
Starting from the technical characteristics of current mainstream blockchain applications such as Bitcoin, Ethereum and Beihang Chain, this paper discusses the functional features and architectural components of different types of blockchain applications. Based on that, a feature-oriented classification method for blockchain applications is proposed. This paper innovatively divides the blockchain application into digital currency blockchain, development platform blockchain, decentralized application and extended blockchain, giving the functional architecture of the corresponding type blockchain application. At last, combined with the example of Power Ledger, we validate the effectiveness of our classification method.

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