STANDARDS

IEEE Standard for Using Blockchain for Carbon Trading Applications

IEEE Computer Society

Developed by the
Blockchain and Distributed Ledgers Committee

IEEE Std 3218™-2022

IEEE

IEEE Standard for Using Blockchain for Carbon Trading Applications

Developed by the

Blockchain and Distributed Ledgers Committee
of the
IEEE Computer Society

8 November 2022

IEEE SA Standards Board

Abstract: Technical framework, application processes and technical requirements for carbon trading applications based on blockchain, including functions, access, interface, security, and carbon consumption voucher coding are described in this standard.

Keywords: application processes, blockchain, carbon trading, IEEE 3218™

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Introduction

This standard specifies requirements and specifications for using blockchain for carbon trading applications. It describes a technical framework for the planning, design, construction and operation of carbon trading systems. The purpose is to improve the efficiency of system interactions, perform lifecycle traceability management of carbon trading applications, enhance the efficiency of multi-subject identity authentication for carbon trading, and thereby improve business efficiency.

Contents

IEEE Standard for Using Blockchain for Carbon Trading Applications

1. Overview

1.1 Scope

This standard specifies technical framework, application processes and technical requirements for carbon trading applications based on blockchain, including functions, access, interface, security, and carbon consumption voucher coding.

1.2 Purpose

This standard specifies requirements and specifications for using blockchain for carbon trading applications. It describes a technical framework for the planning, design, construction and operation of carbon trading systems. The purpose is to improve the efficiency of system interactions, perform lifecycle traceability management of carbon trading applications, enhance the efficiency of multi-subject identity authentication for carbon trading, and thereby improve business efficiency.

1.3 Word usage

The word *shall* indicates mandatory requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted (*shall* equals *is required to*).[1, 2]

The word *should* indicates that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required (*should* equals *is recommended that*).

The word *may* is used to indicate a course of action permissible within the limits of the standard (*may* equals *is permitted to*).

The word *can* is used for statements of possibility and capability, whether material, physical, or causal (*can* equals *is able to*).

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[1] The use of the word *must* is deprecated and cannot be used when stating mandatory requirements; *must* is used only to describe unavoidable situations.

[2] The use of *will* is deprecated and cannot be used when stating mandatory requirements; *will* is only used in statements of fact.

2. Normative references

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ISO 22739, Blockchain and distributed ledger technologies—Terminology.

3. Definitions, acronyms, and abbreviations

3.1 Definitions

For the purposes of this document, the following terms and definitions apply. The *IEEE Standards Dictionary Online* should be consulted for terms not defined in this clause.[3]

blockchain: Distributed ledger with confirmed blocks organized in an append-only, sequential chain using cryptographic links.

NOTE 1—Blockchains are designed to be tamper resistant and to create final, definitive, and immutable ledger records.

NOTE 2—ISO 22739:2020, Blockchain and distributed ledger technologies—Terminology, 3.6.

carbon trading: The major mechanism innovation of coping with climate change and reducing greenhouse gas emissions through market mechanism is an important market means to control greenhouse gas emissions, also called "carbon emission trading."

NOTE—It comes from two international conventions—the United Nations Framework Convention on Climate Change [B2] and the Kyoto Protocol [B1].[4]

3.2 Acronyms and abbreviations

API   Application Programming Interface

4. Stakeholder

4.1 General

The stakeholder of blockchain carbon trading service application refers to the relevant participants involved in the development, operation, service of carbon trading system, including service users, business providers, platform providers, and regulators, as shown in Figure 1.

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[3]*IEEE Standards Dictionary Online* is available at: http://dictionary.ieee.org. An IEEE Account is required for access to the dictionary, and one can be created at no charge on the dictionary sign-in page.

[4] The numbers in brackets correspond to those of the bibliography in Annex A.
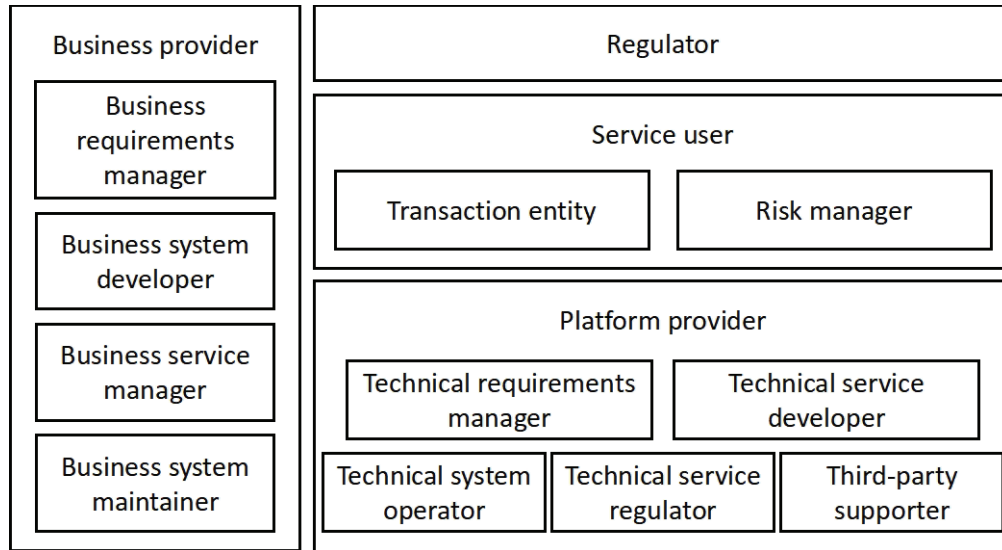
Figure 1—The stakeholder of blockchain carbon trading service

4.2 Service user

4.2.1 Transaction entity

Transaction entity refers to organizations that participate in asset transaction processes such as asset generation, asset transfer, and asset pledge during the application process of blockchain carbon trading services. For example, key carbon emission enterprises conclude asset transactions, and complete operations such as carbon emissions approval, carbon trading execution, and certificate code generation within the specified time limit.

4.2.2 Risk manager

The risk manager is responsible for managing and controlling the blockchain carbon trading situation, integrating the transaction data of the transaction entities, and conducting risk management.

4.3 Business provider

4.3.1 Business requirements manager

A business requirements manager shall be responsible for the requirements design and management of the blockchain carbon trading platform, and revising and improving the requirements through multi-party coordination to form the final version.

The activities of the business requirements manager shall include, but are not limited to, the following:

a) Identify the core requirements of the system

b) Identify the main functional modules and subdivided functional points

c) Form the exploitable and maintainable requirement profiles

4.3.2 Business system developer

A business system developer shall be responsible for sorting out and improving the business requirements of blockchain carbon trading services and analyzing the rationality of system requirements and development

difficulties. This person also helps ensure the consistency between technical implementation and requirements.

The activities of the business system developer shall include, but are not limited to, the following:

    a) Design, develop and maintain the blockchain carbon trading business service system

    b) Test and accept relevant functions of blockchain carbon trading platform

4.3.3 Business service manager

A business service manager is responsible for the management process of the blockchain carbon trading platform. This person provides services for the business processes of users in the platform, helping users to collect and present information in order to facilitate the platform operation.

The activities of the business service manager shall include, but are not limited to, the following:

    a) Prepare the initial data of the platform

    b) Manage data and assets

    c) Monitor and promote system services

    d) Provide business operation data

4.3.4 Business system maintainer

A business system maintainer is responsible for the maintenance process of the blockchain carbon trading platform. This person helps ensure the availability of platform services, the correct usage of the platform by users, and the follow-up maintenance of the entire process of the platform.

The activities of the business system maintainer shall include the following:

    a) Initialize the environment and process

    b) Define the operation methods and operation manual

    c) Maintain the normal operation of the system

4.4 Platform provider

4.4.1 Technical requirements manager

The technical requirements manager is responsible for the requirements design and management of blockchain technology that is corresponded to the blockchain carbon trading service so as to support blockchain and the technology provider in subsequent technology development and maintenance.

The activities of the technical requirements manager shall include, but are not limited to, the following:

    a)   Identify the relevant requirements of blockchain technology.

    b)   Design a reasonable and complete blockchain technology requirement scheme.

4.4.2 Technical service developer

The technical service developer is responsible for evaluating the rationality and feasibility of blockchain technology requirements and designs. This person develops and implements technology according to the requirements, ensuring the consistency of technical implementation and requirements.

The activities of the technical service developer shall include, but are not limited to, the following:

a) Design, develop, and maintain service components or smart contracts in the blockchain system

b) Test and accept relevant functions in the blockchain system

4.4.3 Technical system operator

The technical system operator is responsible for the operation and maintenance process of the blockchain technology service. This person works hard to help ensure that the blockchain technology service and infrastructure meet the operational objectives.

The activities of the technical system operator shall include, but are not limited to, the following:

a) Plan the proper implementation and deployment of blockchain services

b) Provide the whole-process maintenance services of system

4.4.4 Technical service regulator

The technical service regulator is responsible for supervising and managing other technology providers, ensuring the legal and reasonable operation of blockchain services, and maintaining trusted blockchain services.

The activities of the technical service regulator shall include, but are not limited to, the following:

a) Monitor and analyze relevant data

b) Set regulatory rules, examine and regulate blockchain services

c) Provide emergency management services

4.4.5 Third-party supporter

A third-party supporter is responsible for improving the external third-party support services of the supply chain financial service application system (such as network timing service, certificate authentication service, identity authentication service, etc.) in order to help strengthen the system and improve its functions.

4.5 Regulator

The regulator shall:

a) Formulate the monitoring plan; clarify the determination methods of enterprise carbon emission activity data, emission factor data, quota allocation data and so on; and collect as well as record enterprise plans on time.

b) Identify the content applicable to enterprises of carbon trading-related laws and regulations continuously, and pay attention to the coordination with other laws and regulations.

c) Identify and monitor greenhouse gas emissions within the control scope determined by the accounting regulator.

5. Principle

5.1 Compliance principle

The blockchain carbon trading service meets compliance requirements, which shall include, but are not limited to, the following:

a) Take security protection and management measures for enterprise information.

b) Encrypt and sign the relevant data.

c) Abide by the relevant national and relevant laws, regulations and rules.

d) Follow the principles of legality and standardization, integrity and self-discipline, independent and voluntary, maintaining the order of the carbon emissions right trading market, and promoting energy conservation as well as emission reduction.

5.2 Data hierarchical authorization principle

The blockchain carbon trading service adopts a data hierarchical authorization mechanism, which shall include, but are not limited to, the following:

a) Establish user account management system, including user management, role management, authority and authorization management and other measures.

b) Adopt the least privilege principle and multi-role authorization mechanism.

c) Provide data to business stakeholder, service users, and system supporters according to different data access rights and levels.

5.3 Whole-process traceability principle

The blockchain carbon trading service has the ability to trace the whole process, which shall include, but are not limited to, the following:

a) Unique identification and coexistence certificate of assets generated in the whole process.

b) Store all electronic data related to the entire lifecycle of assets, including authorized operation, ownership change and data access.

c) cBlockchain carbon trading service can prove the transaction validity to clients or third parties.

5.4 Safety and reliability principle

The blockchain carbon trading service application helps ensure the safety and reliability of data storage, transmission and application, which shall include, but are not limited to, the following:

a) Help ensure that the identities of business stakeholders are authentic and credible, the assets are authentic and legal, and the business processes are controllable.

b) Implement security measures such as encrypted storage and access control for data. Securely store as well as back up key data. Help ensure the confidentiality, integrity, and availability of data.

c) Help ensure the security of data transmission. Adopt secure upload or download data interface, transmission link encryption, and other security measures to help ensure the confidentiality of data transmission.

d) Use information security technologies and measures to help ensure data application security.

5.5 Business high availability principle

The blockchain transaction service meets the basic requirements of business high availability, which shall include, but are not limited to, the following:

a) The blockchain carbon trading platform has a business downgrade function to help ensure core functional requirements and data consistency when high concurrent traffic strikes.

b) The blockchain carbon trading platform has a rollback function. When the program or data is incorrect, it can be rolled back to the latest correct version.

c) The blockchain carbon trading service has the function of multi-activity across different places, and can provide business services in different regions and geographical locations.

6. Business system framework

The blockchain carbon trading business system can realize different business scenarios of each stakeholder. Different stakeholders and system platform nodes can form a unified business system and trading system of carbon trading through the intercommunication of the blockchain. The blockchain-based carbon trading business system is mainly composed of infrastructure layer, platform layer, data layer, application service layer, and cross-layer service layer. The business system framework is shown in Figure 2.
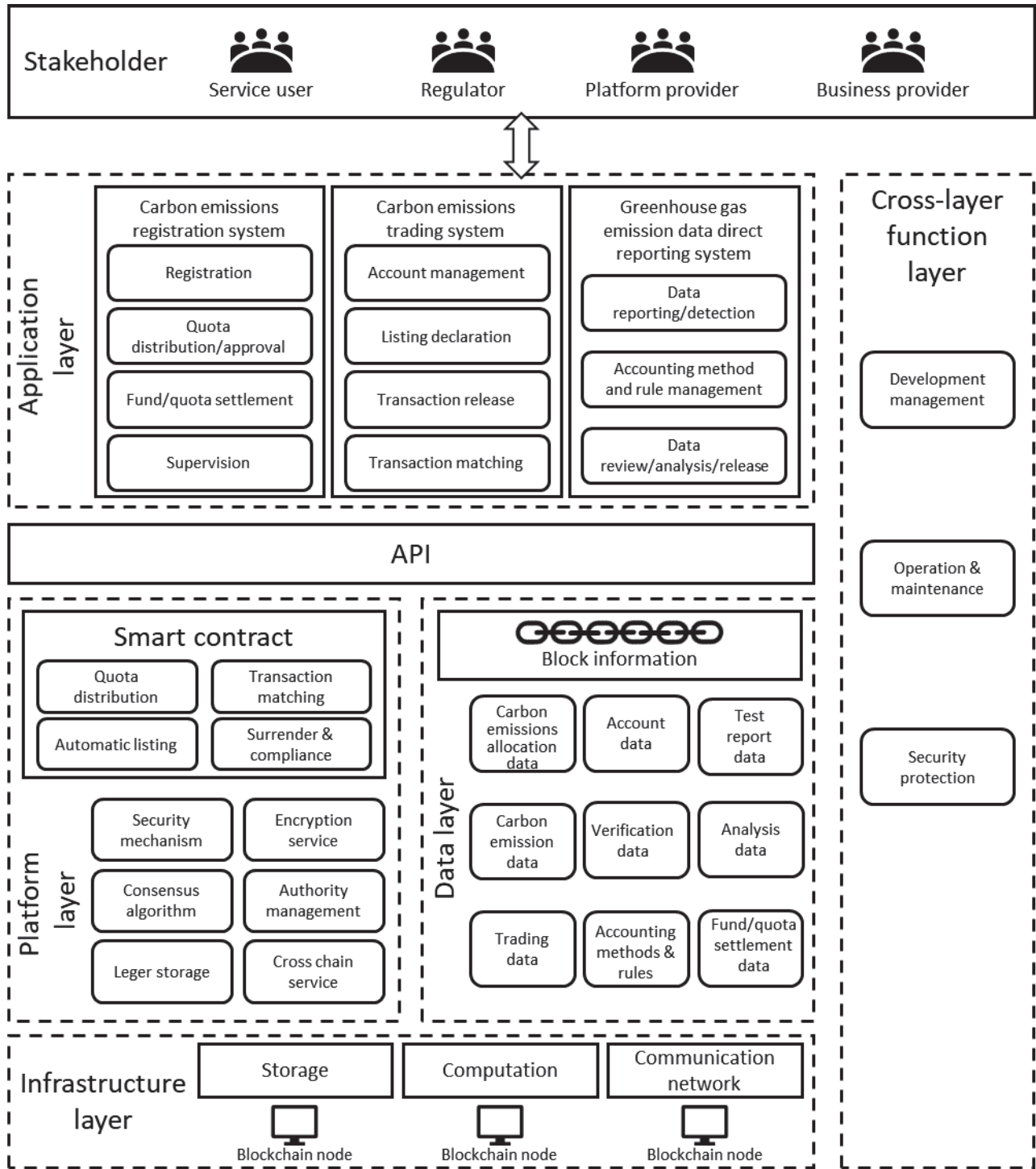
Figure 2—Blockchain carbon trading business system framework

6.1 Infrastructure layer

The infrastructure layer is the basis of blockchain carbon trading application system. It provides the required basic environment and components for the data layer, platform layer, application layer, and blockchain-based carbon trading applications.

6.2 Data layer

The data layer is an important part of carbon trading data collection and the application basis of the blockchain carbon trading application system. The data layer stores and records the data on the carbon trading blockchain. The data in the system are as follows:

a) Carbon emissions accounting methods

b) Carbon emissions data

c) Carbon quota release/allocation/auction information

d) Quotation of quota application and quota auction

e) Registration and settlement of carbon quota information

f) The verification/record/registration information of certified carbon emission reduction project

g) The emission reduction verification/record/registration information of certified carbon emission reduction project emission

h) The transfer listing/transfer confirmation data of certified carbon emission

i) The buyer application/purchase confirmation data of certified carbon emission

j) The listing/transfer confirmation data of trading party

k) The application/purchase confirmation data of trading party

l) Third-party certification to verify emission data

6.3 Platform layer

The platform layer realizes the consensus mechanism, smart contract, security mechanism, authority management, ledger storage, and other functions of the blockchain based on infrastructure layer and the data layer. It supports the services for the upper-layer application of blockchain. Among them, the smart contract function module performs methodological emission calculation contract, automatic carbon emissions listing contract, and transaction matching contracts for the carbon trading business layer.

6.4 Application layer

The application layer is integrated with carbon trading related business, and is the specific application of blockchain technology in carbon trading. The blockchain carbon trading model supported by multi-party business platforms and application systems includes different business scenarios for all stakeholders. Relevant business platform includes the following:

a) Carbon emissions registration system

b) Carbon emissions trading system

c) Greenhouse gas emission data direct reporting system

6.5 Cross-layer service layer

Cross-layer service layer contains functional components that span multiple functional layers to help ensure accurate business management, such as development management, operation maintenance, security protection.

7. Function

7.1 Infrastructure layer

The infrastructure layer contains three functional modules: storage, computing, and network.

7.2 Platform layer

The platform layer specifies the blockchain-based service functions for carbon trading business applications, including ledger service, node communication, consensus mechanism, smart contract for carbon trading business, security mechanism, authority management, cross-chain service, etc.

    a)   Consensus mechanism: A method for decentralized nodes to reach consensus on the validity of block data in a decentralized blockchain network. The Consensus algorithms include Proof of Work (PoW), Proof of Stake (PoS), Delegated Proof of Stake (DPoS), BFT, CFT, etc.

    b)   Smart contract: Various scripts, codes, algorithm mechanisms, etc. with programmable features. It is the basis for the programmable blockchain and provide related business services for carbon trading.

    c)   Cross-chain services: Provide trusted value transfer across blockchain networks for carbon trading. It is required to extend carbon trading to multiple entities, and is responsible for solving the bottlenecks in performance, capacity, privacy, isolation, and expansion under the single-chain architecture.

    d)   Authority management: Provide authority management services for carbon trading entities, such as account authority management, identity access management, etc.

    e)   Ledger service: Provides on-chain data writing and query services.

    f)   Network communication services: Provide secure communication services for blockchain nodes.

    g)   Cryptography services: Provide services such as encryption algorithms, signatures, and verification signatures.

    h)   Security mechanism: Helps ensure identity security, communication security, and data security.

7.3 Data layer

The blockchain data layer specifies the physical form of the blockchain and is responsible for storing all the data information on the blockchain, which is a chain structure composed of blocks.

    a)   The data layer includes the block data, chain structure and random numbers encapsulated in the block, hash values, timestamps of authenticated transactions, transaction information, public and private key data, etc. It helps to ensure the security of all data when the data is disclosed on the whole network.

    b)   The consensus algorithm is used between blockchain network nodes to maintain the consistency of data layer data, and the asymmetric encryption and hashing algorithms in cryptography are used to help ensure that the data information in the data layer cannot be tampered with and traceable.

c) The blockchain-based carbon trading data layer is required to provide applications with service functions such as data storage and data query.

7.4 Application layer

The application services of the blockchain carbon trading system shall realize the business functions listed in Table 1.

Table 1—Blockchain carbon trading business functions

Service System	Stakeholder	Functions
Carbon Emission Allowances Registration System	Transaction entity	Account opening and account management functions
		Carbon asset management function
		Money management function
		Business management function
		Transaction transfer function
	Regulator	User management function
		Quota management function
		Contract regulation function
		Information query function
		Supervision and management function
	Platform provider	Registration management function
		Clearing and settlement management function
Trading System	Transaction entity	Pending orders and transactions
		Customer management
Emissions Data Direct Reporting System	Transaction entity	Data reporting and monitoring
	Regulator	Accounting method and rule management
		Data quality control and auditing
		Data analysis and publishing

7.4.1 Carbon emission registration system

The carbon emission registration system is an electronic system for business management of various market entities, including the registration, settlement and cancellation of carbon emission allowances, and the realization of allowance allocation, settlement, and performance.

The carbon emission registration system is required to store carbon assets and funds in the carbon market, formulate the registration system and its supporting business management rules, and supervise the registration system and its management agencies.

The users of the registration system include competent authorities at all levels, such as registration and settlement management agencies, and key emission entities and other market participants.

Hierarchical management for system users is implemented, which is divided into management layer and market participation layer. The registration system may provide different functions for different types of users.

7.4.2 Carbon emission trading system

According to the carbon emissions trading management system, trading institutions are responsible for the infrastructure provision for trading services and comprehensive information services. The trading system shall support comprehensive functions of the entire carbon emission trading system, such as online account opening, customer management, transaction management, pending order declaration, transaction matching, market release, risk control, market supervision and so on. The functions of the trading system are as follows:

    a)   Transaction: Organize the pending orders, matching and transactions of carbon emission rights

    b)   Information release: Implement real-time release of daily market information and historical market information of carbon emissions trading

    c)   Market regulation: Monitor transaction behavior and give an early warning

7.4.3 Emission data direct reporting system

The enterprise greenhouse gas emission data direct reporting system contains five functions, including comprehensive management, data reporting and monitoring, accounting method and rule management, data quality control and auditing, and data analysis and release. The requirements for management and control functions include the reporting and review of greenhouse gas emission data of key emission units, the management of greenhouse gas emission report of regulatory authorities, the management of greenhouse gas emission methodology, and the comprehensive analysis and release of emission data. The users of the system include regulatory authorities, key enterprises, technical support institutions, and the general public.

7.5 Cross-layer service layer

The cross-layer functional layer includes components spanning multiple functional layers to help ensure accurate business management, including development management, operation and maintenance, security protection, and regulatory auditing. The functions are as follows:

    a)   Management operation and maintenance, which is used to help ensure the safe and reliable operation of the blockchain system or network, including authority management, inspection mechanism, network monitoring and alarm, emergency response, and alliance governance.

    b)   Identity authentication and management, which is used to authenticate and manage the identity of each participant in the blockchain, including identity service interface, identity management service and identity authentication service.

    c)   Compliance audit, which is used to help ensure the supply and use specifications of blockchain business, and carry out risk reduction, including functional audit and security compliance audit.

8. Critical process

8.1 Overview

The key process of the blockchain carbon trading application includes registration on the chain, carbon emission data reporting, carbon allowance registration and approval, transaction demand release, transaction matching, transaction execution, contract performance clearing, identity authentication, etc.

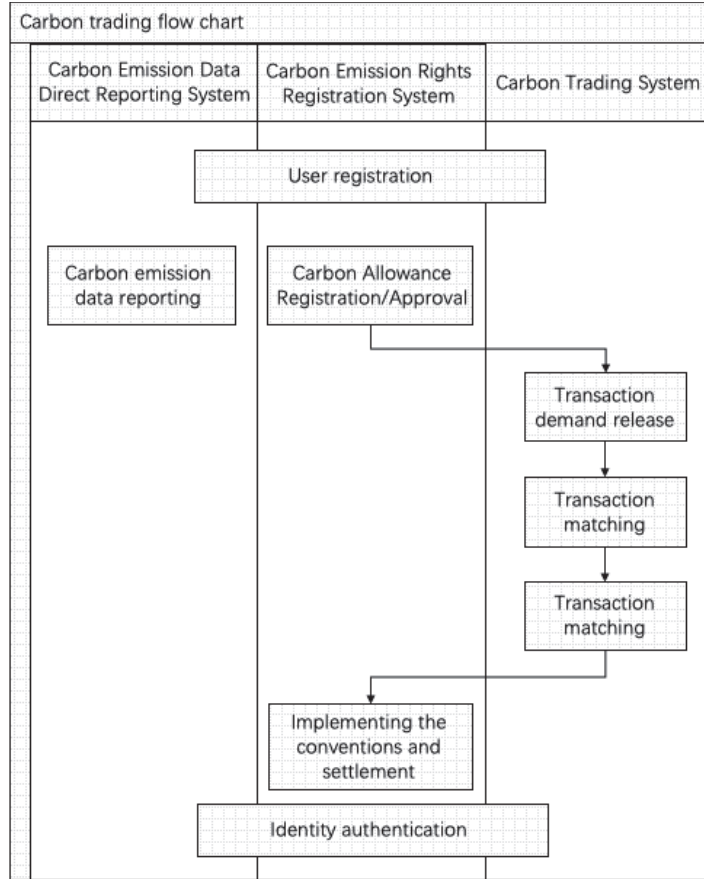The overall transaction model is shown in Figure 3.

Figure 3—Carbon trading process model

8.2 User registration

Trading entities are required to register accounts and trading accounts in the carbon emission rights registration system and the carbon emission rights trading system. The key emission units among the trading entities are also required to register reporting accounts in the carbon emission data reporting system.

The stakeholders of the blockchain carbon trading system shall be registered on the chain. Refer to Table 2 for the registration information.

Table 2—Registration information

Number	Type of information	Information properties
1	Account opening registration information	Name
2		Type
3		Industry
4		Address
5		other
6	Evidence	Copy of Business License
7		Copy of Valid Identification Document of Legal Representative
8		Account Representative Power of Attorney
9	Account opening information of fund settlement account	Bank Account Information

The registration process is as follows:

a) The user initiates a registration application to the registration system through the node terminal application.

b) The registration system sends the relevant policies of this registration back to the user.

c) The user terminal node generates a new pair of public and private keys, which are unique to the user, identity provider, and blockchain.

d) The user sends the registration information and public key back to the registration system as required.

e) The registration system pushes the registration account and fund settlement account opening information to the trading system, and the trading system automatically generates a trading account and completes the opening of the trading account.

f) The registration system saves the user public key and associated user account information.

g) The registration system responds to the user with registration success information.

8.3 Carbon emission data reporting

The key emission units in the trading entities are required to report their carbon emission data to the competent authorities through the carbon emission data reporting system. The competent department allocates carbon allowances to key emission units according to the quota allocation method according to the submitted data. Key emission units determine the actual compliance plans by comparing the carbon emission verification reports submitted by third-party agencies to the carbon emission data reporting system.

The carbon emission data reporting process is as follows:

a) National and regional governments promulgate emission reduction strategies.

b) The enterprise implements the monitoring plan, collects data related to activity levels and emission factors, and conducts data quality management and archiving.

c) The competent authority shall set quotas for emission reduction enterprises based on the greenhouse gas emission data. Quotas can be determined by the following methods:

1) Historical law—Carbon quotas are approved according to the historical emission levels of emission-controlled units, which are suitable for industries with complex production process and product characteristics, such as office buildings and railway stations.

2) Baseline method—Carbon quotas are approved based on industry benchmark emission intensity. This method is suitable for industries with standardized production processes and product styles and scales, such as electric power, thermal power, and heavy industry enterprises.

8.4 Carbon allowance registration approval

The carbon emissions registration process is as follows:

a) The competent authority determines the carbon emission quota of each enterprise. Using the hash algorithm technology and its tamper-resistant character, the quota data of each enterprise and region is uploaded to the chain for distributed storage, and the broadcast mechanism is used to notify each enterprise of events.

b)   The transaction entities conduct self-registration online on the registration system.

c)   The regulator incorporates regulatory policies and other content into the smart contract system through blockchain technology.

d)   The regulator conducts an online review of the carbon emission right qualification of the enterprise based on the smart contract of the review rules.

e)   After passing the audit, the platform party assigns relevant certificates, stamps them with time stamps, and records them in the blockchain.

f)   After reaching a consensus on the approved carbon emission rights by adopting blockchain technology, the platform produce blocks and store relevant information and credentials in the block.

g)   The platform side records the block height and completes the carbon emission right registration.

8.5 Announcement of transaction requirements

According to the trading plan, trading entities shall participate in the paid bidding declaration of carbon emission allowances in the primary market in the trading system. Then trading entities participate in the secondary market listing click buy order declaration and sell order declaration. Trading entities also participate in selling pending orders and buying pending orders that are transferred by the secondary market agreement.

The automatic arrangement and release process of transaction requirements for the blockchain carbon trading platform is as follows:

a)   Enterprises with different emission reduction costs can auction excess allowances or voluntary emission reductions, and register them on the trading platform for listing.

b)   The trading system platform arranges the user's proposed transaction requirements and publishes the user's proposed transaction requirements.

c)   The trading system platform maintains a list of transaction requirements, the range of acceptable transaction prices for buyers and sellers, and a list of matching requirements for carbon trading based on smart contracts.

8.6 Carbon trading matching process

The automatic matching process of carbon trading requirements for the blockchain carbon trading platform is as follows:

a)   The platform provides smart contracts that meet the automatic matching of carbon transactions. According to the transaction requirements put forward by buyers and sellers and the acceptable price range, the transaction matching results are provided.

b)   The automatic matching results of carbon trading are fed back to relevant parties.

c)   Quota transaction process, quantity, price, and other information and ownership information are recorded on the chain in real time. The trading platform performs a private key digital signature. Rules are defined between platforms through blockchain and smart contracts.

d)   The node sends a broadcast message to the consensus layer, and the coordination node and the relevant receiving node perform verification. After the verification is passed, the smart contract is

triggered during the transaction. The transaction information is written into the distributed block, and the transaction is completed.

e) The operating platform party is required to provide relevant technical support services and transaction matching results security services during the automatic matching process.

8.7 Carbon trading execution process

According to the automatic matching results of carbon trading, after the buyer and seller agree to execute the carbon trading, the blockchain carbon trading platform shall execute the following processes:

a) Provide smart contracts that satisfy the automatic execution of carbon trading.

b) Feedback the automatic execution results of carbon trading to stakeholders.

c) When each transaction occurs, the smart contract shall automatically check whether the conditions of the buyer and seller meet the requirements. It also decide whether the order operation can be executed.

d) When an enterprise commits untrustworthy behaviors, the behaviors shall be recorded in the blockchain system in real time. In the next transaction, the enterprise credit information shall be queried.

e) When carbon assets are traded, a transfer of ownership of carbon emission rights occurs, the transaction information shall be recorded in the blockchain and not be tampered with.

f) When purchasing carbon assets, whenever a carbon indicator is purchased, the transaction information shall be recorded in the blockchain and not be tampered with.

g) When carbon assets are sold, whenever a carbon indicator is transfered, the transaction information shall be recorded in the blockchain and not be tampered with.

h) The platform provider can support relevant technical services in the process of automatic execution of carbon trading.

i) The platform provider can supprot the automatic execution results security services of carbon trading.

8.8 Performance and payment process

The key emission unit users among the trading entities are required to submit full quotas or emission reductions to the competent authorities on the registration system to complete the performance obligations. The registration system pre-examines the performance application to form a pre-examination opinion. The competent department can review the application for contract performance based on the pre-examination opinions. After approval, the submitted allowances or emission reductions can be cancelled. The canceled allowances or emission reductions shall not be used again.

The automatic payment and settlement process of the blockchain carbon trading platform is as follows:

a) Record the company's carbon emission activity level and emission factor. The third-party accounting and auditing agency conducts real-time calculation and write-off.

b) The enterprise unit that has completed the verification is registered on the blockchain. The enterprise that fails to pay off as required shall be disciplined according to local policies. If it fails to write off

on time and on demand for many times, operational restrictions and financial penalties shall be imposed.

8.9 Automatic generation of carbon trading voucher codes

After the transaction is concluded between the transaction entities, the transaction system can issue a transaction completion certificate. The voucher is automatically generated by the transaction system according to the transaction time, the order of the day's transactions, and other factors.

The automatic generation process of carbon trading voucher code on the blockchain platform is as follows:

a) Incorporate transaction-related regulatory policies and other content into the smart contract system through blockchain technology.

b) Formulate rules for automatic generation of carbon trading voucher codes.

c) Formulate carbon trading voucher codes to automatically generate smart contracts.

d) After the transaction is completed, platform provider assigns the relevant vouchers, stamps them with time stamps, and records them in the blockchain.

8.10 Authentication

The identity authentication process of the blockchain carbon trading platform shall be as follows:

a) Stakeholders can issue digital certificates through third-party certification agencies.

b) Stakeholder nodes can install digital certificates.

c) The the validity period of digital certificate and the source domain name allowed to be used can be verified.

d) If the verification fails, access participation is prohibited; if the verification is successful, the stakeholder node can communicate with other chain nodes at the network layer and establish a communication dialogue. Roles are accessed by the access control layer on the corresponding chain.

e) The user nodes, such as enterprise, are responsible for sending and receiving carbon trading information, and recording transactions between this node and other nodes. The user nodes shall maintain local ledgers, conduct ledger and listing queries on other transparent transactions on the chain, and can also enjoy platform services. The coordination nodes, such as government departments or third-party regulatory agencies, are responsible for conducting the compliance review and verification of system transactions and registration information, which can maintain system security. The super nodes, such as the organizer of the carbon emission trading market and the blockchain company, have the highest data access rights in the system. The super nodes can modify and delete transaction information, arbitrate transaction disputes. The super nodes are responsible for formulating macro-level carbon trading policies, and coordinating the connection between the system and other third-party institutions.

f) A consensus mechanism is reached by multiple parties. Ordinary participants cannot obtain the source and transaction history of the target, so as to help ensure business secrets. Authorized intended purchasers verify the authenticity. Authorized third parties verify the emission reduction information of voluntary emission reduction projects corresponding to carbon emissions, so as to conduct real-time supervision.

9. Security requirements

The security system shall support the security attributes of the interaction between the various layers of the blockchain carbon trading platform, including confidentiality, integrity, availability, and privacy protection. These security functions are applied in user and node authentication, transaction protocol design, chain data organization, communication channel encryption, and application data access control.

The security system shall include the following functions:

a) Authentication and identity management: Determine whether the user has access and use rights to a certain resource, and help ensure the reliability and stability of the access control strategy of the blockchain system. The authentication and identity management functional components shall include the following functions:

   1) Support the establishment of identity management strategies.

   2) Support the use of specific identity authentication methods to support identity management strategies.

   3) Support the establishment of a user identity management mechanism based on identity authentication.

b) Authorization and security policy management: Determine the rights of authorized users to access or use a resource, and formulate rules that must be followed by all security-related activities in a security area. The authorization and security policy management functional components shall support the following functions:

   1) Authorize users to access and use resource permissions.

   2) Set up authorization and security rules.

   3) Authorization and security rules are controlled by security authorities.

Annex A

(informative)

Bibliography

Bibliographical references are resources that provide additional or helpful material but do not need to be understood or used to implement this standard. Reference to these resources is made for informational use only.

[B1]   Kyoto Protocol to the United Nations Framework Convention on Climate Change, published by the United Nations Framework Convention on Climate Change (UNFCCC), 10 Dec 1997.

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