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Discussion on the Application of Blockchain in the Integrated Construction of Meteorological Network Training Platform

Xiaoling Liu[1,a,*], Jinqiu Liang[2,b]

[1]*China Meteorological Administration Training Center, Beijing, China*
[2]*Datong Meteorological Office, Datong, Shanxi, China*
[a]*liuxl@cma.gov.cn,* [b]*dtliangjq@163.com*
[*]*Corresponding author*

Abstract: *Based on the Internet, the meteorological department started its training in November 2005, and carried out the online training of the national meteorological system through the China Meteorological Distance Education Network. With the development of information technology, the platform has been continuously improved and perfected. Two major upgrades were made in 2011 and 2015. Since 2015, the Teaching Management Platform, Display and Interaction Platform, MOOC Platform, and other platforms have been developed and launched one after another. From around 2019 to now, there have been multiple platforms used together in meteorological online training. Each platform stores students' training information and learning records. The longer the training lasts, the bigger the data islands become, subsequently complicating the process of integration. The application of blockchain technology is expected to end the isolation among platforms, achieve information fusion and platform integration. This study delves into the application idea of blockchain technology in the integration of meteorological training platforms and articulates the viability of blockchain technology implementation, corroborated by instances of successful applications.*

Keywords: *Meteorological, Network, Training, Blockchain, Platform Integration*

1. Introduction

Over the past two decades, the domain of network training for meteorological personnel has evolved significantly. It has transitioned from focusing primarily on singular aspects such as forecasting and observation to a more holistic approach encompassing a well-structured training system. This initiative has successfully trained nearly half a million individuals, significantly contributing to the advancement of meteorological endeavors.

The evolution of this network training is intrinsically linked to the development and refinement of the training platforms, which are increasingly influenced by advancements in network, computer, and media technologies. Consequently, there is a continuous need for the enhancement and modification of these platform functionalities. Since the platform was put into use in late 2005, less than ten years of operation has found that the meteorological platform cannot meet the training needs. This led to initial efforts to augment the existing platform, followed by the creation of a new platform. Despite these efforts, the new platform still lacked comprehensive functionality. Since 2019, multiple platforms have been used at the same time; but, each platform has its own data server, thus forming numerous data islands [1]. The following problems occurred during the use process:

(1)Complexity due to multiple platforms: The proliferation of platforms complicates the training process; staffs have multiple learning accounts and passwords, often leading to confusion or forgetfulness regarding platform accounts and passwords.

(2)Issuance of a high volume of training and learning certificates: The current platform only provides face-to-face training certificates, for other training participation, learning proofs needed to be obtained by contacting the class supervisor, who would then apply to the Academic Affairs Office for review and official stamping. A large number of training proofs need to be issued every year, this process imposes a significant administrative burden on both educators and trainees.

(3)Challenges in training data statistics: The decentralization of training data across various

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platforms presents significant logistical challenges. Trainees are required to navigate multiple platforms for learning, while administrators must engage in labor-intensive data importation, exportation, and integration across these platforms.

The emergence of the above issues has led to dissatisfaction among users; these issues need to be addressed properly for meteorological network training to continue to develop stably under the guidance of new technologies. This article will explore how to use the concepts of blockchain technology to address these issues.

2. Blockchain and Meteorological Training

Blockchain technology is abstracted from the underlying technology of Bitcoin. According to different application scenarios and designs, it is mainly divided into public chains, consortium chains, and private chains, each tailored to specific application scenarios and design requisites [2]. Within the context of the meteorological department's training platform, the application of blockchain technology is predominantly aligned with the private chain model, where access and participation are regulated by authoritative entities. Upon entering the workforce, an employee's learning account is established by an administrator on the training platform and subsequently decommissioned upon retirement. The personnel data for these accounts is provided by the personnel department, rather than through independent registration by the trainees.

The blockchain technology has four primary attributes [2]: decentralization, immutability, transparency and traceability, and collective maintenance. The concept of decentralization in blockchain does not imply the absence of a central authority, but rather suggests a model where control is distributed across multiple nodes [3]. In recent years, training organizers ignore the role of the provincial training department, because the network training without limit, and can directly face each staff, the original network training level 3 system is removed many. But if the training task only concentrated on the national, each training number will be quite a lot, plus the digital technology is not enough, training mistakes are inevitable, so if hoping to have good results, we should make full use of the distributed concept of blockchain, actively play the role of provincial and municipal training departments, and work together to maintain the meteorological training block.

3. Exploration of the Application of Blockchain in the Integrated Construction of Meteorological Network Training Platforms

The correct application of blockchain in the integrated construction of meteorological network platform can establish collaboration and trust among national, provincial, and municipal administrators, as well as employees of various meteorological stations, ensuring that all information is shared. This simplifies work processes, improves work efficiency, and reduces communication costs [4].

3.1. Current Status and Improvement Methods of Training Platforms

Currently, trainees have access to at least seven training platforms, including the Meteorological Distance Education Network, Teaching Management Platform, Meteorological E-Tang, Live Streaming System, Display and Interaction Platform, MOOC Platform, and Virtual Training Platform. Among these, the Meteorological Distance Education Network was established earliest and contains trainee information, learning resources, trainee asynchronous learning records, course completion certificates, and training examination systems. The Teaching Management Platform holds trainee information, face-to-face training registration information, course evaluations, training summaries, and graduation certificate information. The other platforms mainly deal with related information data for remote live streaming classes. A common feature of these platforms is that they are open to all personnel within the meteorological department and others engaged in meteorological services in other industries. Each of these individuals has the opportunity to study on multiple platforms, and each platform's system database stores relevant training information. The current situation is shown in Figure 1.

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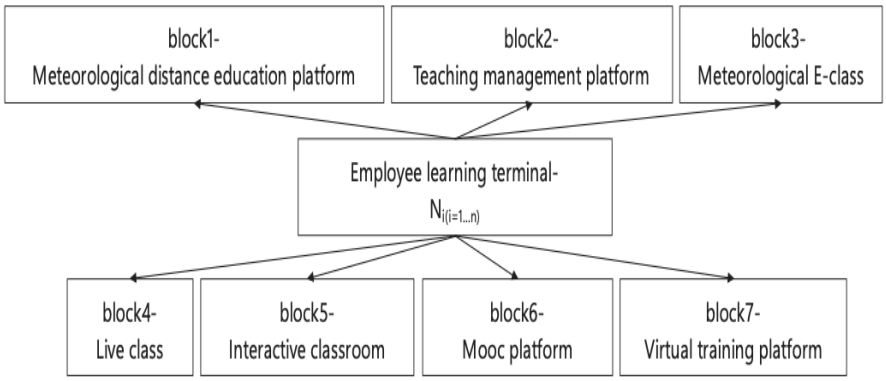

Figure 1: Current situation of meteorological training platform, trainees log into different training platforms according to the training requirements.

The reason for multiple platforms and multiple IDs is that some administrators believed that different platforms should have different ID numbers when establishing IDs. It was not until the platforms had been operating for some time and had accumulated a considerable amount of learning data that teachers and students began to provide feedback on this issue. However, taking measures requires approval time, and administrators often change, leading to data isolation that grows larger over the years, and the difficulty of integration increases. In the second half of 2022, the meteorological department began the process of integrating the ID numbers across various platforms. Initially, the work involved using the staff's name as a comparison feature. After half a year of work, it was discovered that when superfluous ID numbers of the same student were closed, the learning records associated with the closed ID numbers also disappeared, sparking a new round of issues.

Given the complexity of trainees participating in training due to the previous independent operation of various platforms, it is preferable to establish a meteorological training blockchain when coordinating and rectifying the training platforms. Although trainees have different ID numbers on different platforms, the ID card numbers provided by the personnel department for employees are unique and can be used as the sole identifier to associate learning information of trainees on different platforms. The original independent training blocks are linked into a large training block, with pointers linking the blocks. The operation information of employees logging into any platform is interconnected, allowing the learning information of trainees on different platforms to be integrated together (Figure 2) [5-6] .

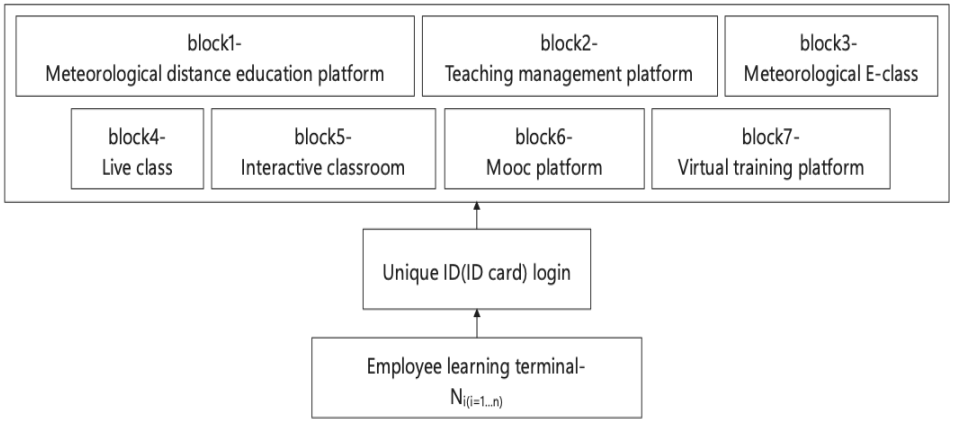

Figure 2: Meteorological training blockchain schema

After applying the concept of blockchain to improve the system, integration is achieved using the ID card as the unique identifier, while also retaining the original login methods. Currently, there are three login methods available: the original ID number, ID card number, and mobile phone number (Figure 3).As it stands, this diversity in login options not only offers flexibility to users but also ensures that the transition to the Integrated construction. Trainees can choose the most convenient or familiar method to access their training materials, thereby ensuring training continuity.

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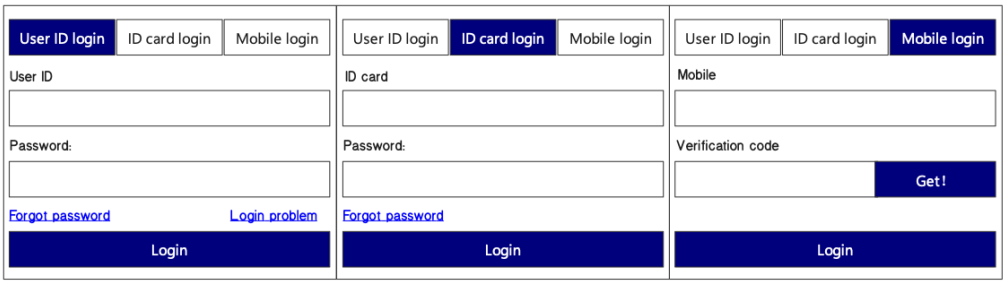

Figure 3: Improved three login methods

3.2. Blockchain Solutions for Teaching Certification and Data Statistics

The distributed storage structure of blockchain is collectively maintained, which can not only back up data to prevent information loss but also reduce the workload of a single database. The core of blockchain is not to abandon centralized management for decentralization, but to build a multi-party trust mechanism, which is a trustworthy system architecture participated by multiple parties [7]. The Meteorological Administration Training Center has two branches in Hunan and Xinjiang, and six research centers in Hebei, Liaoning, Sichuan, Zhejiang, Guangdong, and Shaanxi. A distributed storage system of 1 + 2 + 6 can be established (Figure 4): storing student information, teacher teaching information, student learning records, and learning resources, etc. Distributed servers can reduce the congestion and lag caused by a single courseware resource server (Figure 5). Administrators of provinces within each region can maintain the student information of their province in this sub-center. This management model can build a new ecosystem with multi-party participation and secure trust, reduce the burden of national administrators, provide job opportunities for sub-centers, promote collaborative development, and ensure a smooth learning experience for staffs from all provinces. Meanwhile, distributed servers can better avoid hacker attacks on the network, prevent damage to a single server, and solve the problem of fault tolerance [8], ensuring data security.

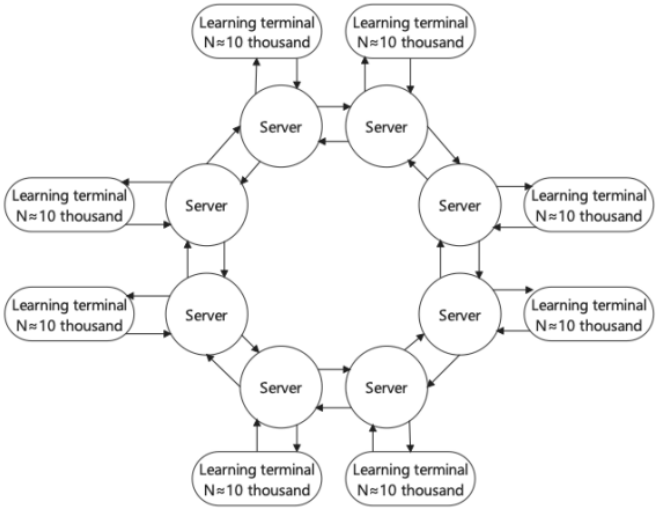

Figure 4: Establish a training structure after the distributed storage of the blockchain, an average of 10 thousand staffs log on to one server

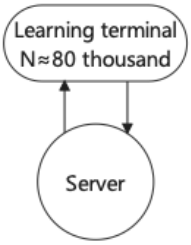

Figure 5: Current training structure, nearly 80 thousand staffs were logged in to a single server

In the integrated construction of the meteorological training platform, the three technical cores of

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the blockchain are applied: distributed networks, encryption algorithms, and consensus mechanisms [9]. Key aspects of this integration are manifested in the following aspects:

(1)Data synchronization and security: When new resources are added or information is modified, the data is automatically synchronized 8 distributed servers. Each server employs encryption algorithms for verification. Once information is verified and added to the blockchain, it becomes permanently stored. Alterations to the database on a single node are ineffective unless over 4(in weteorological training block) of the system's nodes are simultaneously controlled, ensuring high stability and reliability of blockchain data [10-11].

(2)Digital asset transformation, proof of workload and teaching record validation: The application of blockchain technology transforms learning into a digital asset [12], representing a digital measure of students' capabilities. This mirrors the concept of Bitcoin mining, where each student's learning process is akin to mining efforts, recognized upon meeting assessment requirements. This consensus mechanism ensures that a record's validity is determined by the consensus of all nodes in the block. Students' learning efforts are recognized by the entire network as proof of workload [13], this allows provincial administrators to access and verify students' learning information from the blockchain as a valid proof of learning. Alike, teachers' instructional records are also authenticated across the entire network.

(3)Data statistical analysis: With the establishment of the blockchain, learning data is associated with unique identifiers (ID card numbers). This obviates the need for exporting and integrating data across each platform. Instead, an optimized statistical program can be designed on the visual interface, streamlining the data analysis process. This method not only enhances efficiency but also maintains the integrity and confidentiality of the data.

Overall, the adoption of blockchain in the meteorological training infrastructure offers a robust, secure, and efficient approach to managing and validating educational data, making the system more resilient and adaptable to the evolving needs of both students and educators.

4. Blockchain Application Case

In contrast to the myriad of platforms utilized for training meteorological staff, a notable implementation of blockchain technology is evident in the meteorological government management system, inaugurated in July 2019. This system is bespoke for the staff of the national meteorological department, ensuring a distinct and secure identity for each member. All activity records, including access and modifications within the office platform, are recorded into the blockchain associated with each user's single identity. This approach ensures a secure and traceable log of interactions within the system.Its system architecture and management is as follows:

(1)Unified management by national meteorological information center: The Center is responsible for overseeing the user interface and the primary server, ensuring cohesive system operation and management.

(2)Provincial information centers and directly affiliated units: These entities host distributed servers, which are depicted in Figure 6.

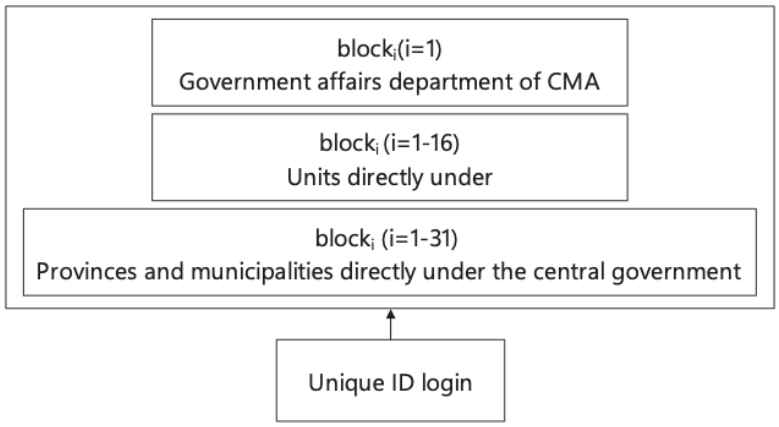

Figure 6: Schematic diagram of the government office system block of the meteorological department

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(3)Role of distributed servers: The distributed servers serve two critical functions: They alleviate the load on the master server, ensuring efficient and uninterrupted system performance. They act as data backup points, enhancing the system's resilience against data loss and tampering.

Since the implementation of the government office system, the meteorological department staff have greatly benefited from its convenience and efficiency. The system has streamlined the office process, providing notification prompts and SMS reminders at each node. This feature enables a notification process to be completed across 6-7 nodes within a single day. In contrast, the previous teaching management platform lacked such prompt reminders, where a process could extend over half a year without special telephone alerts.

Moreover, staff can access information and files across different provinces with ease, thanks to the verified login system. The system negates the need for letters of introduction, personal introductions, and physical travel or mailing, thereby reducing time costs and office expenses.

Although the government office system and the training platform differ in terms of service target and content, their underlying design philosophy is similar. The training platform's overall construction could benefit from adopting the government office platform's design concepts, enhancing its efficiency and user experience.

5. Conclusion

In this study, we explored the application of blockchain technology as a strategic solution to address the fragmentation commonly observed among the seven independent platforms within the meteorological training department. This approach aims to counter the prevalent 'data island' phenomenon, fostering a more integrated and efficient system. Our analysis substantiates the efficacy of blockchain in enhancing the government office system, highlighting its potential in establishing a trust-based, interoperable framework across multiple platforms. This technology not only facilitates the fusion of identities and learning records across diverse platforms but also ensures traceability and shared access to platform operations and information. Such an integrated system is instrumental in mitigating risks associated with single server failures and data loss, while simultaneously streamlining work processes and reducing training costs [4].

The issue of data islands has been a lingering impediment in the advancement of meteorological training [14-15], often overshadowing the high quality of the training content. However, the integration of blockchain technology, coupled with a unified single authentication login system, heralds a promising transformation. We posit that the standardization of the training platform, underpinned by blockchain, will elevate the meteorological training sector to a new echelon, thereby contributing significantly to the high-quality development of meteorological services.

Acknowledgement

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