

# BLOCKCHAIN TECHNOLOGY AVIATION APPLICATION AND DEVELOPMENT PROSPECTS

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**Abstract:** Blockchain technology is a cutting-edge emerging technology that has received widespread attention and development in recent years, and its application exploration in the aviation field has gradually increased. This article studies the current application status of blockchain technology in foreign aviation fields is discussed, and future application scenarios are discussed based on the current status of domestic civil aircraft development, focusing on the analysis of aircraft parts. Information management, digital twin construction and business jet business model innovation are three directions, and suggestions are provided for the future application and development of blockchain technology in the aviation field, with a view to promoting exploring the application of blockchain technology in civil aviation.

**Keywords:** Blockchain; Civil aviation; Application; Outlook

## 1 INTRODUCTION TO BLOCKCHAIN TECHNOLOGY

A new round of scientific and technological revolution and industrial upgrading are reshaping the global innovation landscape, Reshape the global economic structure. Emerging technologies represented by blockchain are accelerating Achieve application breakthroughs and promote higher-quality development of the real economy. Blockchain technology It originated in the digital economy, but in recent years its application fields have continued to expand, and innovative applications have continued to emerge. The main reason is that this technology breaks through the current credit system and provides a decentralized, open and equal new type of information for the field of multi-party collaboration. Use the system, solving the pain points existing in development, promoting the business model Innovation.

The aviation industry is a large and complex industry. In the future 20 years of global innovation Demand for commercial aircraft reaches approx. 40,000. The aviation industry has a long industrial chain, There are many participants, extremely high safety requirements, and strict supervision. The characteristics of blockchain technology overlap with the development needs of the aviation industry, and there are a wide range of future development and application scenarios. Currently, foreign major manufacturers, system suppliers, airlines and other parties are carrying out exploratory applications of blockchain technology. This article sorts out and summarizes this. Analyzed the potential application directions of future blockchain technology in the aviation industry and proposed relevant Development suggestions are provided in order to provide development direction for the domestic aviation industry and promote the cross-border integration of blockchain technology and the aviation industry.

Blockchain technology is a distributed accounting technology and a new technology that integrates encryption technology, Peer to Peer (P2P), consensus mechanism, and distributed data storage. type application model. Its essence is a decentralized database jointly maintained by multiple parties. It uses encryption technology to protect transmission and access security, and can realize data Store consistently, be difficult to tamper with, and prevent repudiation.

### 1.1 Data Layer

A chain structure that encapsulates the underlying data block. In addition to containing its own In addition to data, related asymmetric public and private key data encryption and hash calculations are also stored. Methods, digital signatures, timestamps, etc. are the lowest data structures of blockchain technology.

### 1.2 Network Layer

Including distributed networking mechanism, data transmission mechanism and data verification machine System etc.

### 1.3 Consensus Layer

Various applications based on blockchain, its essence is a decentralized application (Dapp). Decentralized applications run simultaneously on all nodes in the network. Reach a consensus through the consensus mechanism to ensure the consistency of the results, so that Dapp application The status is confirmed in the blockchain network.

## 1.4 Incentive Layer

An economic incentive issuance mechanism and allocation mechanism can be added to the public chain. system, by introducing economic factors to encourage nodes that abide by the rules and participate in accounting, Also restrict nodes that do not follow the rules, making the entire system move in a benign direction develop. As shown in Table 1.

**Table 1** Blockchain characteristics and advantages

characteristic	excellent potential
Decentralization	Distributed storage of data; equal rights and obligations of any node
openness	Set the public key and private key. In addition to encrypting the private information of the transaction subject, other Data is open and transparent
Transparency	All transactions are broadcast in real time; transaction records are distributed to all nodes
autonomy	Code is law, no human intervention
Data is not easily tampered with	Data is permanently stored and timestamped on the chain. ; Difficulty downloading open systems to tamper with
anonymity	You can only obtain transaction content information other than yourself, and cannot view the true identity of the transaction.
Privacy	Information on the chain has limited access; it can only be viewed with authorization

## 2 CURRENT STATUS OF AVIATION APPLICATION OF BLOCKCHAIN TECHNOLOGY

Currently, major commercial aircraft manufacturers such as Boeing and Airbus, suppliers such as General Electric (GE) and Rolls-Royce, as well as some airlines, rely on parts traceability and knowledge The exploration and application of blockchain technology have been carried out in aspects such as property rights protection (see table 2).

**Table 2** Summary of blockchain technology aviation applications

time	company	application
2016.05	Loyyal	Built based on blockchain and smart contract technology Universal Loyalty Rewards Platform
2017.05	boeing	Improvement based on blockchain and IoT Aircraft manufacturing and operation level
2017.08	Aeron	Blockchain-based flight logs and aircraft maintenance data data platform
2017.10	Air France	Manage active aircraft based on blockchain
2017.12	SITA	Coordinate flights based on Ethereum and smart contracts Delay conflicting information and communicate instantly
2018.05	airbus	Form a blockchain working group
2018.05	brussels airport	Develop with blockchain Open data sharing platform
2018.07	Singapore Airlines	KrisFlyer frequent flyer program launches digital technology based on blockchain word wallet
2018.07	Lufthansa Industry	Launched aviation blockchain project to find potential applications and create Build industry standards
2018.09	airbus	Heritage, a blockchain-based donation platform
2019.05	GE	Developing a 3D printed quantum secure blockchain network platform
2019.05	GE	GE engine parts traceability based on blockchain
2019.08	MOOG	3D printing process data based on blockchain
2019.09	Luoluo	Real-time engine data sharing based on blockchain
2020.01	NASA	Air traffic management based on blockchain technology
2020.03	boeing	Open parts trading based on blockchain platform

### 2.1 IATA Releases "Aviation Blockchain White Paper"

IATA believes that blockchain is one of the technologies that may have a significant impact on the future of aviation, and continues to track the development and application of this technology. 2018 IATA released the "Aviation Blockchain White Paper", listing the five major future aspects of blockchain. Application scenario [3].

Blockchain can try to solve the following types of problems in airline operations in the future: (1) Optimize the management of frequent flyer points and simplify point calculation; (2) Track the status and location of valuables; (3) Simplify passenger identity management, enhance experience, and ensure Protect privacy; (4) Promote cooperation with airlines, travel agencies and distribution companies to optimize Serve.

IATA's application prospects for blockchain technology in civil aviation operations The development has pointed out the direction and made more companies in the aviation industry aware of this technology. plays an important role in promoting the development of blockchain technology.

## **2.2 Blockchain Technology is Used for Traceability and Tracking**

### **2.2.1 Boeing parts traceability solution**

The aircraft life cycle process mainly includes design, manufacturing, delivery, operation, Maintenance and decommissioning, accurately track each process and keep relevant records very difficulty.

Boeing proposes improvements based on Internet of Things (IoT) and blockchain technology Aircraft parts traceability solution. The Internet of Things is used to trace the circulation records of parts and components, and the blockchain ensures the authenticity and credibility of the data. This traceability system can improve the efficiency of parts management, simplify the traceability process, and ensure the authenticity and credibility of the data. manufacture As blockchain nodes, dealers, operators and maintenance providers, as well as bureaus, can access this some information. Currently, this technology has been applied to Boeing 787 is in production.

### **2.2.2 GE startup TRUEngine Blockchain Initiative**

Aircraft engines are current assets, and second-hand transactions involve engine flight Maintenance records, parts circulation, etc. Selling at the ideal price requires relevant records Documentation, but its credibility cannot be effectively proven in many cases.

GE and Microsoft Azure Collaboration builds blockchain-based supply Chain tracking system for monitoring the manufacturing and life cycle of key parts of aircraft engines Relevant data for the period. This system can track engine manufacturing, delivery and transportation row data. pass TRUEngine blockchain initiative, GE improves engine and zero Part traceability and record keeping to facilitate the influx of well-documented engines second-hand market.

## **2.3 Cross-Border Integration of Blockchain Technology 3D Printing**

Blockchain and 3D printing integration can improve the material flow and data of the manufacturing process. Control data, intellectual property and personnel to provide process safety assurance. from raw materials to printing as a digital process, recorded and analyzed through blockchain technology Distributed storage ensures the safety of the entire process. In the network, with equipment and Every identity related to designs, machines, materials, components and people is automated Quickly verify, record and manage data to ensure data integrity and authenticity.

Moog carry hand ST Aerospace fight together make based on zone piece Chain VeriPart System, for 3D printing for traceability. The VeriPart system is powered by Developed by Microsoft Azure blockchain technology can improve 3D printing services and Safety, optimizing the supply chain in the aviation market. GE has developed a 3D A secure blockchain network for printing. The system is designed to manage and protect raw materials from 3D printing process to finished product, encrypted data is expected to withstand quantum computers attack [4].

## **2.4 Blockchain Technology Applied to Aviation Operations**

For the safety of aviation operations, Aeron proposes a smart block-based The chain's flight solutions can collect relevant information from pilots, operators, maintenance providers, etc. Data provided by interested parties. Pilots and airlines provide flight logs, air traffic control The data is automatically processed and verified through the data center, and the bureau can monitor its flight license. Certification time; operators can submit airport service data; maintenance providers can submit maintenance Records; if there is a mismatch between multiple data sources, the authority can quickly detect and resolve it question. This software can effectively improve flight safety. Relevant data are stored In the blockchain, data security is increased and openness and transparency are ensured.

For supply chain management, Air France-KLM uses blockchain technology and go Centralized application that achieves the goal of automating the aviation supply chain. in that In the blockchain network, operators enter contracts or transactions at each stage into the blockchain. Verify and confirm. Securing the aviation supply chain through automated transactions.

For frequent flyer points management, Singapore Airlines Group KrisFlyer frequent travelers Passenger Plan launches the world's first airline loyalty data based on blockchain technology Word wallet to help passengers use KrisFlyer miles are redeemable at Singapore Airlines partner merchants Daily consumption.

In the past two years, blockchain technology has been widely used in the aviation field, and companies including major manufacturers, suppliers, and operators have carried out related projects. explore. Blockchain technology in supply chain traceability management and integration 3D printing and other emerging technologies technology, protection of intellectual property rights, and optimization of quality management. New solution path.

### 3 ANALYSIS OF FUTURE AVIATION APPLICATIONS OF BLOCKCHAIN TECHNOLOGY

Blockchain has a high degree of applicability in areas that require multi-party trust. Before using blockchain technology to solve problems, you need to judge its applicability. Generally judge whether Using blockchain technology requires analysis of the following 6 questions to determine if the problem can be solved using blockchain, and which blockchain to choose.

Currently, China's commercial aviation field is developing rapidly, and blockchain technology is The aviation field has a wide range of application prospects. Made for commercial aircraft owners business, combined with the actual needs of domestic aviation manufacturing business and the characteristics of blockchain technology points, the following three major application directions are worth exploring.

#### 3.1 Aircraft Parts Information Management Based on Blockchain

current, parts traceability based on Internet of Things technology has been applied Use [5-9] . However, the data obtained based on the Internet of Things is distributed and isolated in multi-party systems. , data sharing is difficult due to competition and other related factors. Data can neither Accessed by relevant parties and cannot be trusted by relevant parties. commercial aircraft safety The requirements are extremely high, and real and effective information on parts and components must be mastered to prevent tampering. The possibility of changing data requires a more effective component data collection method [10] . Aircraft parts information management based on blockchain is shown in the figure 5 shown.

Manage aircraft parts traceability data based on blockchain technology. Use Internet of Things technology to collect data on the entire life cycle of parts, including factory, Logistics, warehousing, assembly, repair, trading and scrapping. Detailed data for each status is uploaded to the blockchain for verification. Parts manufacturers, main manufacturers, Operators, MRO companies, bureaus and other relevant parties serve as the joints of the blockchain to optimize the manufacturing process; operators can monitor the status of the aircraft in real time, related Retaining credible data will also effectively increase the residual value of the aircraft and its parts; MRO Enterprises can predict aircraft based on credible records of aircraft operation and maintenance data. Test maintenance; the authority can use blockchain for airworthiness management work.

According to calculations by the Boston Consulting Group, the supply chain is implemented based on blockchain technology. Data sharing can effectively reduce credit communication costs, accounting for 10% of revenue 0.28 % ~ 0.56 % . By improving inventory management, carrying costs can be reduced as a percentage of revenue 0.17 % ~0.26 % .

By combining blockchain technology with IoT technology and applying it to parts management management, it can effectively strengthen the main manufacturer's control over suppliers to achieve Precise control of parts and components to truly realize the traceability and traceability of parts and products tracking, effectively reducing management costs and increasing profit margins.

#### 3.2 Blockchain-Based Digital Twin Optimization

In the era of digital twins, data will become one of the important assets of enterprises, but Is a one-way data transfer that will lead to the loss of control of data assets?. Therefore, carrying When transferring high-value digital twins of large amounts of data to interested parties, it is necessary There is a mutual trust mechanism that restricts its survival period and application scope, and in this way The supervision cannot be tampered with unilaterally [11-13] .

The use of blockchain technology will effectively solve this problem. The collection process of digital twin data is mainly realized through the Internet of Things technology and uses blockchain technology Record to ensure the authenticity of aircraft design, manufacturing, operation and maintenance process data performance and reliability.

During the aircraft design phase, aircraft configuration management is the process of establishing and maintaining product technology. The most important discipline for technical integrity. The current configuration management still has complicated processes. Weaknesses, incomplete records, tampering vulnerabilities and other shortcomings, the configuration management of the aircraft is Validity, authenticity pose challenges. Based on blockchain technology, the aircraft's Every configuration change is recorded completely, truly and comprehensively, and all changes are recorded The data is saved on the chain and updated in real time. It not only authenticates the authenticity of configuration changes, but also ensures The mark of modification is left to facilitate traceability management and provide support for the aircraft's subsequent airworthiness, manufacturing and Lay a solid foundation for optimization.

During aircraft operation, aircraft real-time data collection describes the aircraft status as The key to digital twin technology. Authentication of data based on blockchain technology to ensure Prove the authenticity and credibility of

the data. Based on these data, the status of the aircraft can be analyzed and maintenance predictions provide tremendous support. Aircraft can be reshaped based on aircraft operating data. Maintenance methods effectively support predictive maintenance, reduce unplanned maintenance; improve maintenance efficiency, reducing routine inspection and maintenance time, improving asset utilization; trusted records. Key information, including the identity, location and type of aircraft maintenance related maintenance personnel, ensure valid and accurate records of maintenance. PwC analysis found that blockchain technology applications can MRO cost reduction approx. \$ 3.5 billion.

Based on blockchain technology, aircraft digital twins can be optimized and constructed to ensure the authenticity and reliability of digital twin data. Airlines can base their The data enables real-time status control of a single aircraft and effective management of the entire fleet.

### **3.3 Business Model Innovation for Business Jets Based on Blockchain**

At present, the commercial operation of regional aircraft in China has gradually developed. official business The machine market will become another promising market. But currently business jet rental The main problems currently existing in the leasing business are high purchase costs, expensive operating costs, and low production costs. products/services same service quality change strict Heavy,high sex Price/performance product strict Heavy deficient lack, pin for sale become Bengao [14-15] . Based on blockchain technology, it can create a system focusing on main manufacturers, operators, consumers It is a business jet cooperation platform for domestic business jets and provides support for domestic business jets to develop markets.

The platform can bring together interested manufacturers, operators, investors, bureaus, Suppliers, platform service providers, etc. are included as nodes. The platform service provider is responsible for providing a cooperation platform and building an ecosystem; the main manufacturer is responsible for providing business aircraft products and obtaining business aircraft orders; the operator is responsible for the daily operation and maintenance of business aircraft, and collects operating service fees; the investor is responsible for providing business aircraft purchase funds With the money, you have the ownership of the business jet, enjoy the service of the business jet, and can transfer the service rights in the market.

The cooperation platform is built based on blockchain technology and is the basis for communication and collaboration among all parties. foundation. The platform uploads all data collected from all parties to the blockchain to ensure that the data The authenticity, reliability and completeness of data, including asset data, cash flow data, Equipment data, etc., to ensure that relevant parties can obtain the data within their authority in a timely and effective manner. and build a platform for mutual trust among all parties.

The business jet sales model based on blockchain technology mainly includes Down 4 o'clock.

#### **3.3.1 Aircraft usage rights sharing**

Business aircraft procurement uses the collective strength of investors to reduce financial pressure and share usage rights. Based on blockchain technology to ensure investors' aircraft use rights and consumption fee rights.

#### **3.3.2 Investment and consumption linkage**

Use investment to drive consumption in the business aircraft market and expand the market to the investor level face, forming a decentralized marketing system.

#### **3.3.3 Business on-chain**

Put aircraft operation data on the chain to ensure that all data is authentic and trustworthy. Transparent management of investment rights and interests solves the trust crisis.

#### **3.3.4 Equity issuance transactions**

Divide investment interests into digital assets using blockchain, and digital assets can To exchange for flight rights, unused rights can be traded in the platform trading market. trade.

## **4 SUGGESTIONS FOR FUTURE DEVELOPMENT**

As a distributed accounting technology, blockchain technology uses ingenious technical design and data governance methods to provide a trust base for multi-party collaboration work. foundation, helping to solve business development pain points and promote business model innovation. Summary of this article This article summarizes the typical applications of blockchain technology in the aviation field and puts forward targeted The development direction of blockchain technology application provides a basis for the development of blockchain technology in the aviation field. Provide reference for exhibition applications. Regarding the application of blockchain technology in the aviation field, the main I would like to offer three suggestions.

### **4.1 Pay More Attention and Carry out Basic Research**

Blockchain technology is a typical representative of the development of emerging technologies in recent years. It is one of the important achievements of scientific and technological progress and has received great attention at the national level.

First of all, we must enhance our ideological understanding and deeply understand the impact of blockchain technology on the future. Huge potential to drive change in social industries. Blockchain technology is expected to become a breakthrough A key technology that breaks and reshapes production relations.

Secondly, make a good talent reserve. Blockchain technology originated in the field of digital currency field, its initial application is far away from the aviation field, resulting in the technology being closely related to the aviation field. Domain's current human resources cross-over is insufficient. To increase the talent pool of technical personnel preparation, and strive to cultivate a group of new talents who understand both aviation and blockchain technology to provide blockchain technology has laid a solid foundation for its implementation in the aviation field.

Third, solidly advance the level of basic research. Blockchain technology itself has Unique advantages, in order to promote its application, it is necessary to have a relatively good understanding of the technology itself deep understanding. It is necessary to actively carry out basic research and research on technology, understand the development development origin, carry out in-depth research on technical principles, understand the technical connotation, and lay a good foundation for development A solid foundation for application.

#### **4.2 Strengthen Application and Emphasize Problem Solving**

Blockchain technology is currently widely used in the financial field, and it drives the continuous optimization of applications and the continuous improvement of levels. It can be found that combining technology with industry needs Integration, actual use, continuous improvement and improvement in application are the key to accelerating the application of technology in this field. A good way to develop the field. Therefore, it is necessary to strengthen the relationship between blockchain technology and the aviation field Integration, actively analyze and select the aviation fields that blockchain technology can solve problems, match needs with blockchain technology, and find suitable applications direction, expand the scope of application, and let blockchain technology provide solutions to problems encountered in the aviation field. Provide better solutions and improve the level of aviation technology. In application development area Blockchain technology realizes the optimization and upgrading of the technology itself.

#### **4.3 Strengthen Cross-Border Cooperation and Build an Ecosystem**

Blockchain originated from digital currency and is currently used in finance, insurance, and government affairs., Extensive application exploration has been carried out in people's livelihood, medical and other fields, and a number of enterprises with strong technical reserves have been formed. With the development of business, a deeper integration of blockchain technology and the real economy will be the inevitable development direction in the future. Therefore, we must also fully study and learn from the application results and accumulated technologies of blockchain technology in other fields, strengthen cross-border integration, actively create a platform for cross-border cooperation between blockchain technology and the aviation field, and promote related ecology The establishment of the system will promote the implementation of blockchain technology in the aviation field.

### **COMPETING INTERESTS**

The authors have no relevant financial or non-financial interests to disclose.

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