Implementation Plan for Low-altitude Intelligent Network

Abstract

This paper aims to propose a comprehensive and feasible implementation plan for low-altitude intelligent network to promote the healthy development of low-altitude economy and improve the operational efficiency and safety of low-altitude aircraft.

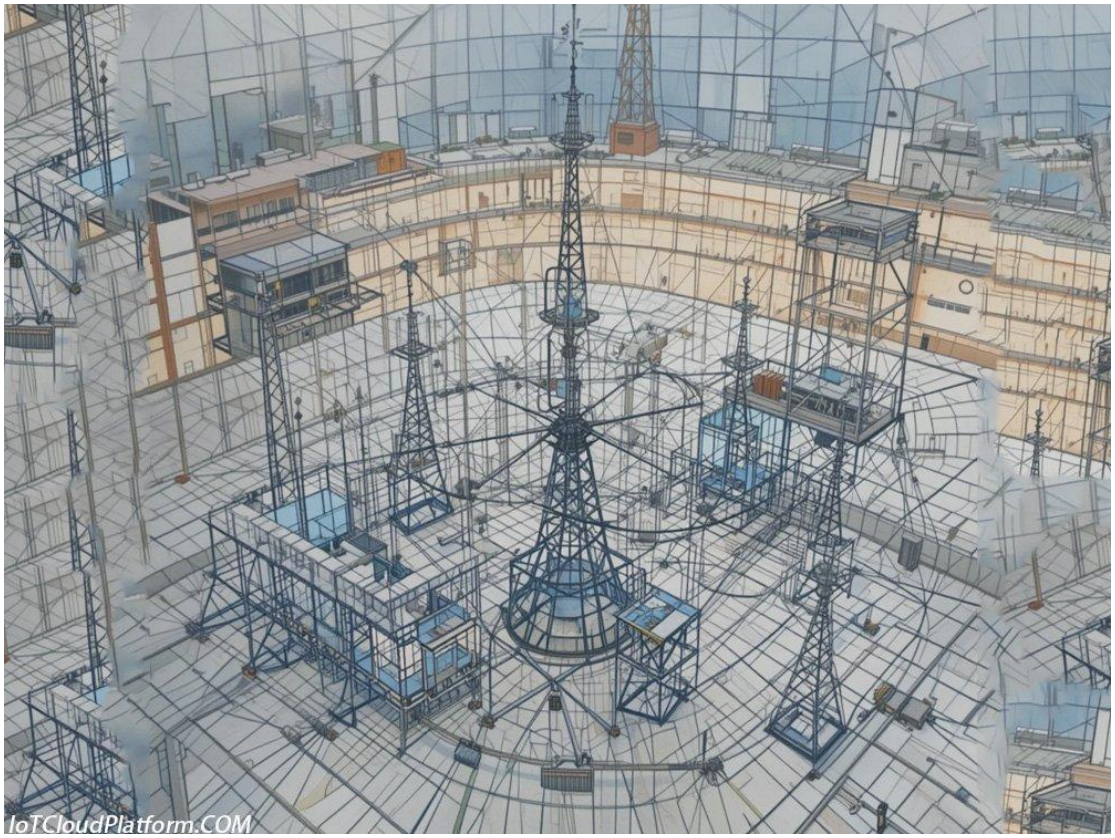
As a multi-dimensional intelligent network system, low-altitude intelligent network includes key elements such as low-altitude aircraft, air traffic management system, ground communication network, sensor equipment, etc. This paper will elaborate on the technical architecture, key technology application, implementation steps, security assurance and industrial ecological construction, in order to provide theoretical basis and practical guidance for the construction of low-altitude intelligent network.

Keywords

Low-altitude intelligent network; **low-altitude economy**, **air traffic management**, **5G communication**, **autonomous driving technology**

I. Introduction

Low-altitude economy refers to economic activities that use drones, light aircraft, air taxis and other aircraft to carry out various businesses with low-altitude airspace as the core. With the continuous advancement of technology, the gradual liberalization of policies and the growing market demand, the low-altitude economy has developed rapidly around the world and has become an important force in promoting emerging industries such as modern transportation, intelligent logistics, urban air travel, and environmental monitoring.



Implementation Plan for Low-altitude Intelligent Network

As an important infrastructure to ensure low-altitude flight safety, improve operational efficiency, and promote industrial integration, the construction and implementation of the low-altitude intelligent network is of great significance to promoting the high-quality development of the low-altitude economy.

1.1 Research background

In recent years, with the advancement of aviation technology, there have been many technological breakthroughs in the field of low-altitude economy, such as electric vertical take-off and landing (eVTOL) aircraft and drone cluster control technology, which have greatly expanded the application scenarios of the low-altitude economy. However, the rapid development of the low-altitude economy has also brought huge challenges to flight safety and airspace management. How to build an efficient, safe and intelligent low-altitude intelligent network has become the key to achieving high-quality development of the low-altitude economy.

1.2 Research significance

The construction of a low-altitude intelligent network can not only improve the operational efficiency and safety of low-altitude aircraft, but also promote the

integrated development of low-altitude economy-related industries. The implementation plan proposed in this paper will provide a theoretical basis and practical guidance for the construction of the low-altitude intelligent network, which will help promote the healthy development of the low-altitude economy.

II. Overview of Low-altitude Intelligent Network

The Low-altitude Intelligent Network is an intelligent network system composed of low-altitude aircraft, air traffic management system, ground communication network, sensor equipment and other multi-dimensional components. Its goal is to achieve efficient scheduling, intelligent management, cross-platform collaboration and information sharing of low-altitude aircraft.

2.1 Key elements

- **Low-altitude aircraft**: including drones, flying cars, small aircraft, etc. These aircraft need to have the ability of automatic driving or remote control.
- **Ground control and monitoring system**: responsible for real-time monitoring and scheduling of the flight trajectory, speed, position, etc. of low-altitude aircraft.
- **Air Traffic Management System (ATM)**: provides low-altitude aircraft with track planning, flight guidance, obstacle avoidance and air traffic flow control.
- **Data transmission and communication system**: adopts 5G, Lora, satellite communication and other technologies to achieve efficient data exchange between low-altitude aircraft and ground stations and air management systems.
- **Perception and recognition technology**: including the air collision avoidance system (TCAS), radar, optical sensors, lidar, etc., used to identify obstacles, weather changes and other aircraft in the surrounding environment.
- **Cloud computing and big data platform**: Provide data storage and computing capabilities, process flight data in real time, conduct trend analysis, improve flight efficiency, etc.

2.2 Technical architecture

The technical architecture of the low-altitude intelligent network is a multi-level and multi-dimensional system framework, which usually includes the following levels:

- **Perception layer**: Collect various data such as aircraft, environment, ground facilities, etc. through hardware devices such as sensors, cameras, radars, GPS, etc.
- **Transmission layer**: Use communication technologies such as 5G, satellite communications, and Wi-Fi to transmit the data of the perception layer to the central control platform or cloud platform in real time.

- **Processing layer**: Data storage and computing are performed through cloud computing and big data platforms, providing intelligent decision-making support such as flight path planning, traffic control, and obstacle avoidance strategies.
- **Application layer**: Based on the data processing results of the upper layer, provide specific services to users and managers, such as real-time track display, route optimization, and fault warning.

III, Key Technology Application

3.1 Autonomous Driving Technology

Autonomous driving technology is the core technology that enables low-altitude aircraft to operate autonomously in complex environments. Combined with artificial intelligence (AI) technology, aircraft can perceive the surrounding environment in real time and make decisions based on data feedback, such as avoiding obstacles and adjusting flight trajectories. The autonomous driving system needs to use computer vision, deep learning, reinforcement learning and other technologies to enable it to make efficient decisions in dynamic environments.

- **Computer Vision and Sensing Technology**: Through image recognition, lidar, ultrasonic and other sensors, aircraft can obtain three-dimensional information of the surrounding environment in real time, perform collision warning and obstacle avoidance.
- **Deep Learning and Reinforcement Learning**: Deep learning helps aircraft identify complex ground and air environments, and reinforcement learning enables aircraft to optimize decisions and improve autonomous capabilities during continuous flight.

3.2 Air Traffic Management Technology

The management of low-altitude airspace is more challenging than that of high-altitude airspace, especially in the context of large-scale commercial low-altitude aircraft. Air traffic management (ATM) needs to be more precise and intelligent to improve the efficiency of aircraft traffic and avoid conflicts.

- **Flight path optimization**: Optimize flight paths through algorithms to reduce flight time, save fuel, and avoid unnecessary detours.
- **Traffic management and airspace coordination**: Introduce traffic management and airspace division technologies to reasonably dispatch aircraft, avoid excessive concentration of aircraft, and ensure flight safety.

3.3 5G communication technology

The high speed, low latency, and wide coverage of 5G communication technology provide strong support for real-time data transmission, remote control, and flight safety assurance of low-altitude intelligent networks.

- **Low latency communication**: 5G networks can provide millisecond-level latency, which is crucial for aircraft safety control, data feedback, and task scheduling.
- **Internet of Things technology**: Internet of Things (IoT) technology can connect ground facilities, aircraft, sensors, and other equipment to the network to achieve real-time information sharing and monitoring.

IV, Implementation Plan

4.1 Phased construction

The construction of a low-altitude intelligent network needs to be carried out in stages to ensure the feasibility and effectiveness of implementation.

- **Phase I**: Infrastructure construction. Including large-scale deployment of 5G-A base stations, low-altitude communication network coverage, and construction of ground control and monitoring systems.
- **Phase II**: Application and testing of key technologies. Based on the infrastructure, introduce autonomous driving technology, air traffic management technology, perception and recognition technology, etc., and conduct system testing and optimization.
- **Phase III**: Application promotion and industrial ecosystem construction. Based on the maturity of key technologies, promote the application of low-altitude intelligent networks in logistics distribution, urban air travel, environmental monitoring and other fields, and build a complete industrial ecosystem.

4.2 Key tasks

- **Promote 5G-A low-altitude communication network coverage**: Carry out low-altitude communication network coverage in stages, take the lead in achieving full coverage of low-altitude flight routes in key areas, and support large-scale operation of low-altitude services.
- **Deploy 5G-A low-altitude perception network**: Deploy low-altitude perception networks based on 5G-A on demand to meet low-altitude security needs such as all-weather intrusion monitoring and alarm.
- **Explore the integrated satellite-ground communication network**: Take advantage of the wide-area coverage of satellites to explore a new model of three-dimensional coordinated coverage of air, ground and space, with 5G-A network as the main network and satellite network as the supplement.

- **Deploy a low-altitude intelligent computing system with cloud-edge-network-end coordination**: Improve the construction of intelligent computing infrastructure, deploy a low-altitude intelligent computing system with cloud-edge-network-end coordination, and realize real-time intelligent processing of low-altitude aircraft and user data.

4.3 Policy support and regulatory construction

- **Formulate low-altitude network construction specifications**: Formulate technical standards and construction specifications for low-altitude communication networks based on the performance requirements of low-altitude application scenarios with interawareness integration.
- **Improve the low-altitude information service system**: Encourage information and communication companies to actively participate in the construction of low-altitude flight supervision service platforms, and provide diversified information services such as navigation positioning, route planning, and risk warnings.
- **Strengthen network and data security assurance**: Explore the construction of low-altitude economic network and data security compliance systems, and enhance the research capabilities of network and data security technologies in the low-altitude economic field.

V. Safety Assurance

The safety of aircraft is a key issue in the construction of low-altitude intelligent network. In order to ensure the normal operation of aircraft, a sound flight safety monitoring system must be established.

5.1 Flight Safety Monitoring System

By integrating sensors, radars, optical cameras and other equipment, the flight status, surrounding environment and potential risks of the aircraft are monitored in real time to ensure flight safety.

5.2 Data Encryption and Privacy Protection

Adopt advanced data encryption technology to protect the security of flight data during transmission and storage. At the same time, strengthen privacy protection policies to ensure the legal and compliant use of user data.

5.3 Emergency Response Mechanism

Establish a sound emergency response mechanism, including fault warning, emergency braking, accident investigation and handling processes, to deal with possible flight safety issues.

VI. Industrial Ecosystem Construction

Building a sound low-altitude intelligent network industry ecosystem is an important guarantee for promoting the high-quality development of the low-altitude economy.

6.1 Investment Attraction and Industrial Chain Integration

Through investment attraction, attract high-quality domestic and foreign enterprises to participate in the construction of low-altitude intelligent network and form a complete industrial chain. At the same time, strengthen the cooperation and integration of upstream and downstream enterprises in the industrial chain to enhance overall competitiveness.

6.2 Innovative Application and Demonstration Promotion

Relying on the wide-area coverage capability of low-altitude intelligent network, expand emergency rescue applications such as aviation firefighting, aviation rescue, public health, and emergency communications; deepen aviation logistics distribution applications such as takeaway and express delivery; explore eVTOL urban air traffic applications such as business travel, air shuttle, and private charter; expand new consumer applications such as low-altitude tourism. Through demonstration and promotion, gradually expand the application scenarios and market influence of low-altitude intelligent network.

6.3 Talent Training and Technological Innovation

Strengthen cooperation with universities and scientific research institutions to cultivate professional talents in the field of low-altitude intelligent network. At the same time, encourage technological innovation and promote the continuous upgrading and optimization of low-altitude intelligent network technology.

VII. Conclusion and Outlook

Building a low-altitude intelligent network is an important measure to promote the high-quality development of the low-altitude economy. The implementation plan proposed in this article elaborates on the technical architecture, key technology

applications, implementation steps, security assurance, and industrial ecosystem construction.

In the future, with the continuous advancement of technology and the gradual improvement of policies, the low-altitude intelligent network will play an important role in more fields and contribute more to the prosperity and development of the low-altitude economy.

7.1 Research Conclusion

Through the research in this paper, we draw the following conclusions:

- **Technical feasibility**: The construction of low-altitude intelligent network depends on the mature application of key technologies such as autonomous driving technology, 5G communication technology, and air traffic management technology. With the continuous development of these technologies, the construction of low-altitude intelligent network has become possible.
- **Clear implementation steps**: The phased construction plan proposed in this paper, from infrastructure construction to key technology application testing, and then to application promotion and industrial ecosystem construction, has clear steps and is operational.
- **Safety assurance is important**: Flight safety is the core issue of the construction of low-altitude intelligent network. Through flight safety monitoring system, data encryption and privacy protection, emergency response mechanism and other measures, flight safety can be effectively guaranteed.

7.2 Future Outlook

- **Technical innovation continues to promote**: In the future, with the continuous development of technologies such as artificial intelligence, Internet of Things, and blockchain, low-altitude intelligent network will achieve more intelligent and efficient operations.
- **Application scenarios continue to expand**: Low-altitude intelligent network will play a greater role in logistics distribution, urban air travel, environmental monitoring, emergency rescue and other fields, and promote the prosperity and development of low-altitude economy.
- **Increasingly perfect policy environment**: With the continuous development of low-altitude economy, relevant policies and regulations will be gradually improved to provide a more favorable policy environment for the construction and operation of low-altitude intelligent network.

VIII. Case study

8.1 Case 1: Construction of low-altitude logistics network in a certain city

Background: A certain city plans to build a low-altitude logistics network to improve logistics distribution efficiency and reduce traffic congestion.

Implementation plan:

- **Infrastructure construction**: Deploy 5G base stations around the city to ensure low-altitude communication network coverage. At the same time, build a ground control and monitoring system to monitor and dispatch low-altitude aircraft in real time.
- **Technology application**: Introduce autonomous driving technology to realize autonomous flight and obstacle avoidance of low-altitude aircraft. Use air traffic management technology to optimize flight paths and improve logistics efficiency.
- **Safety assurance**: Establish a flight safety monitoring system to monitor flight status and potential risks in real time. Use data encryption technology to protect user privacy.

Effect: The construction of a low-altitude logistics network has effectively improved logistics distribution efficiency and reduced traffic congestion. At the same time, through intelligent management, operating costs are reduced and user satisfaction is improved.

8.2 Case 2: Upgrading the air traffic management system in a certain region

Background: The air traffic flow in a certain region is increasing, and the original air traffic management system can no longer meet the demand.

Implementation plan:

- **System upgrade**: Introduce advanced air traffic management technology, upgrade the original system, and improve the system processing capability and intelligence level.
- **Data integration**: Integrate data resources such as ground control and monitoring systems and sensor equipment to achieve information sharing and collaborative management.
- **Emergency response**: Establish a complete emergency response mechanism to improve the system's ability to respond to emergencies.

Effect: The upgrade of the air traffic management system has effectively improved the air traffic flow processing capacity and reduced flight conflicts. At the same time,

through data integration and the establishment of an emergency response mechanism, the overall safety of the system has been improved.

IX, Challenges and Countermeasures

9.1 Challenges

- **Technology maturity**: Although autonomous driving technology and 5G communication technology have made significant progress, they still need to be further improved to meet the high requirements of low-altitude intelligent networks.
- **Policies and regulations**: The policies and regulations of the low-altitude economy are not yet perfect, and top-level design and policy guidance need to be strengthened to provide strong guarantees for the construction and operation of the low-altitude intelligent network.
- **Safety guarantee**: Flight safety is the core issue of the construction of the low-altitude intelligent network, and effective measures need to be taken to ensure flight safety.

9.2 Countermeasures

- **Increase R&D investment**: Encourage enterprises, universities, scientific research institutions, etc. to increase R&D investment and promote key technological breakthroughs and innovations.
- **Improve policies and regulations**: Strengthen top-level design and policy guidance, and formulate and improve the policy and regulatory system for the low-altitude economy.
- **Strengthen safety guarantee**: Establish safety guarantee measures such as flight safety monitoring system, data encryption and privacy protection, and emergency response mechanism to ensure flight safety.

X, Conclusion

Building a low-altitude intelligent network is an important measure to promote the high-quality development of the low-altitude economy. This article elaborates on the technical architecture, key technology applications, implementation steps, security, and industrial ecosystem construction, and proposes a phased construction plan.

Through case studies, the effect of low-altitude intelligent networking in practical applications is demonstrated. At the same time, corresponding countermeasures are proposed for existing challenges.

In the future, with the continuous advancement of technology and the gradual improvement of policies, low-altitude intelligent networking will play an important

role in more fields and contribute more to the prosperity and development of the low-altitude economy.

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