

# [EN-A-054] Research on the architecture of UAV-ATM information platform based on mobile 4G network

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**Abstract:** With the rapid development of China's national economy, civil small unmanned aerial vehicles called UAV, have been widely used in aerial photography, aerial mapping, traffic command, fire detection, fishing vessel monitoring, emergency rescue and so on . At the same time, due to lack of effective technical means and methods dealing , the UAV operation and management are not perfect g with dynamic understanding and master which resulted serious problem of global concern of the UAV safe operation. Based on the analysis of the current situation of UAV, this paper puts forward the architecture of UAV-ATM information platform based on mobile 4G network, as well as the architecture of UAV-ATM information platform and the functions of UAV-ATM information platform accordingly. The research work has reference meaning for realizing technical methods and the information management of UAV, and promoting the safety supervision technology of UAV.

**Keywords:** UAV, mobile-4G network, UAV- ATM platform, architecture and function

## 1. INTRODUCTION

Unmanned Aerial Vehicle, named UAV, is the use of radio remote control equipment and self-contained program control device of unmanned aircraft. In recent years, with the rapid development of China's national economy, civilian UAV have been widely used in agriculture, power oil, disaster prevention, forestry, meteorology, land resources, police, marine water conservancy, mapping, urban planning and so on in reference1 and 2. In the UAV production enterprises in the birth of the DJI-Inovations, ZEROTCEH, XAIRCRAFT, YIDian Science, YiHang UAV, Tianxiang UAV and other well-known enterprises both here and abroad, provide a good opportunity to promote the development of UAV.

But at the same time the UAV without flight plan, un-authorization flight and UAVs black fly phenomenon have been increased sharply which has resulted the serious and danger in much times. It is reported that UAV and air force fighter "encounter", UAV fall in the downtown area caused serious impact on resident safety and property. In addition, the relevant network reported that the UAV flight plan of lack of reporting, has resulted in the relevant companies caused a serious impact on civil aviation and military.

Otherwise in the process of China's current UAV operation, non-flight plan declaration, un-approval and other illegal phenomena are existed in large fields. Furthermore because the people do not understand China's UAV flight program application procedures and work processes, people still have the original thought with un-approval application, resulting UAV flight activities mostly un-approval, black fly phenomenon.

This article analyzes and summarizes the above research results, and puts forward the research on the architecture of civil UAV air traffic management (UAV-ATM) information platform based on mobile 4G network in view of the current situation of civil small UAVs in reference3 and 4. Firstly, It is introduced the technical characteristics and advantages of mobile 4G network. Then, the architecture of UAV-ATM is put forward with information platform. Finally, the function of UAV-ATM information platform is analyzed in detail. The research work has a certain reference for realizing technical methods and the information management of UAV, and promoting the safety supervision technology of UAV.

## 2. PROBLEMS IN THE DEVELOPMENT OF UAV

## 2.1 UAV development trend

In recent years, with the development of consumption levels and concepts, domestic and foreign civilian small UAVs developed quickly. In 2010, France's Parrot company released the world's first truly concerned about the four-wing UAV AR. Drone. It is not only easy control with achieved hover, but also the image and video could be transferred to mobile and phone with bluetooth or wifi connection. AR.Drone has so many advantages with light weight, flexible used, easy operate and so on which have eventually won a great success. Under the guidance of AR.Drone, the global launch a multi-rotor commercial boom, multi-rotor aircraft entered a period of the rapid development. At present, China's DJI (DJI-Innovations), the United States 3D Robotics, France Parrot have become the leading enterprises in civil UAV world.

It is reported that early aeronautical technology is to solve the problem of UAV can fly. Since 1980s, the development of modern technology has provided a higher flight performance and better reliability for the UAV, including the following aspects:

- Intelligent. With the independent flight control technology and the rapid computer processing capabilities have promoted the development of UAVs which has let air robot "can think";
- High-speed bandwidth. With high-speed broadband data link and the UAV network and interconnection, the unmanned aircraft group has joint into possible with open space equipment.
- Lighter materials and sensors. With materials science and micro-electromechanical technology, the further weight of the UAV platform has reduced sharply and improved accuracy.
- And stronger endurance. With battery lives longer and longer, new energy technology has given UAV more endurance flight time.

## 2.2 UAV development problems

However because of the low-altitude airspace without large-scale openness, UAV industry is stayed in first initial stage. It is insufficient on UAV safety supervision and operation and other institutional mechanisms and technical means in reference5, 6 and 7, mainly in the following several aspects:

- The mechanism of safety supervision system needs to be improved

It is issued that the Basic Rules for the Flight of the People's Republic of China has been issued, as well as the General Aviation Flight Control Regulations, the General Operation and Flight Rules, the Civil Aircraft Patents and Ground Instructors Certification Rules, and other relevant laws on general aviation Regulations. With the civil unmanned aircraft system driver management regulations, civil UAVs air traffic management approach, light UAV operation requirements and so on are issued accordingly.

Air traffic management and operation and regulations for the UAV are carried out respectively. But the implementation of UAV safety regulation is not perfect, the UAVs development needs with air traffic management, the operation of laws and regulations.

- Lack research of UAV safety monitoring technology

In recent years, Civilian UAVs has a leap-forward development, market size and market conditions with unprecedented progress. With the certain reasons, the research of UAV safety regulatory technology is still lagging behind, as well as the UAV monitoring system, the regulatory platform. Although some companies have put forward the UAV monitoring technology and platform, such researches are just use with specific Machine and specific operating environment without a wide range of operating conditions and the environment. The UAV industry is still insufficient. The urgent need for safety control technology is still a problem to promote the UAV Industrial benign development.

- Lack of UAV safety regulatory information collection and integration method

Although the relevant UAV safety supervision has issued, UAV operation required information collection and integration has yet to be achieved, and has not yet established a corresponding means of information collection and integration.

- And lack of UAV air traffic management information safety system

With the rapid development of navigation and UAV industry, UAV safety monitoring and UAVs data communication network has not yet established. Especially the UAV air traffic management of information safety platform has not yet been established to adapt the large data operating environment.

Therefore, in order to adapt to the future development of low-altitude airspace under the conditions of the rapid development of UAV industry, the use of advanced UAV safety monitoring and UAV operation concept and IT service architecture, based on mobile broadband air transport network UAV air traffic management information Platform to improve China's UAV industry and UAV operation safety and level is imminent.

## 3. MOBILE 4G NETWORK

The basic principle of mobile 4G communication network is to set up a group of base stations on the ground. Each ground base station is connected by optical fiber to form a broadband communication network covering specific airspace. The aircraft could establish the connection through the airborne communication equipment and ground base stations to establish communication links, and

complete the space between the broadband data communications.

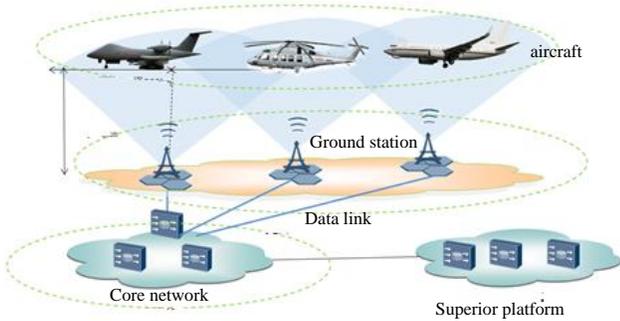


Fig.1 The platform of Mobile 4G network

The advantages of mobile 4G backbone network and metro network security solutions are concentrated in the following three capabilities:

- Recover redundancy of comprehensive network  
China Mobile 4G transmission network have achieved 1+1 backup. In the aspects of backbone network and metro network equipment, it has achieved full network equipment. The transmission of network resources achieved a physical dual routing. In terms of power security, transmission network related core network equipment are equipped with UPS to ensure power uninterrupted.

- Design transmission network self-healing  
China Mobile puts the ability of integrate network self-healing into network design and construction. If the network goes wrong (such as fiber break, equipment failure), the network will automatically recover in a very short period of time without human intervention, so that the customers almost do not feel the network getting fault.

- And complete network security monitoring and emergency response capability

China Mobile has the world's largest communications network monitoring center. And China Mobile has established network management to ensure that all layers of transmission network can work 24 hours a day. Customers could use the best perception focus on monitoring, centralized management.

Compared with satellite communications, mobile 4G communication network has many advantages, the lower cost of construction and using, lighter weight of airborne equipment, lower power consumption, and lower cost and bandwidth.

Consideration the UAV operation characteristics, mobile 4G can solve the related technical problems during UAV operation including following aspects,

- improve the UAV real-time monitoring with complex flight environment ,
- improve the UAV effective means of communication of flight service process,
- And enhanced UAV safety operation of massive data

in complex environment.

#### 4. UAV-ATM INFORMATION PLATFORM BASED ON MOBILE 4G NETWORK

##### 4.1 Platform architecture

The mobile 4G communication network has macro cellular network architecture based on ground facing aircraft. Through building networked ground base station (signal to the air radiation), it provides UAV broadband communication link between airborne equipment and terrestrial base station, which could generate the mobile 4G communication network within certain airspace.

UAV-ATM is composed of eight parts (sub-system or sub-platform) in reference8 and 9. The platform system architecture is shown in Figure 2.

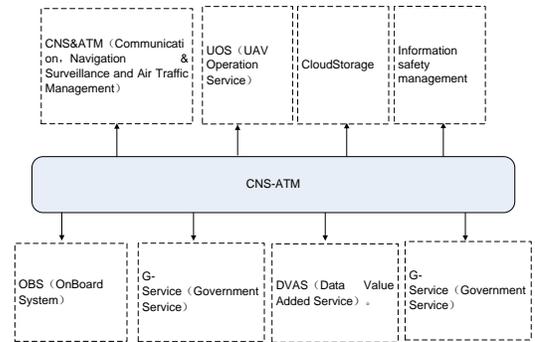


Fig.2 platform system architecture

As is shown in the figure, the platform architecture includes the following sub-systems, OnBoard System (OBS), Communication, Navigation & Surveillance and Air Traffic Management (CNS&ATM), Government Service (G-Service) , UAV Operation Service (UOS), Data Value Added Service (DVAS), CloudStorage, Statistics and Data Mining (DSDM), and Information Safety Management (ISM).

##### 4.2 Platform function

###### (1) OnBoard System

OnBoard System (OBS) consists of dedicated airborne CNS modules (or devices) and API that provide different SDK of CNS for different types of UAV. And the API modules are identical to implement unification of UAV communication standard interface.

###### (2) Communication navigation and surveillance and traffic management platform

Communication, Navigation& Surveillance and Air Traffic Management (CNS-ATM) is working during the UAV operation.

- Communication uses the China Mobile 4G network.
- Navigation consists of the GPS / BD / MEMS hybrid positioning, GPS / BD differential positioning, and 4G Cell-id positioning.
- Surveillance could supply such functions, 4D track storage: store real-time UAV 4D track data, 4D track surveillance and alarm: 2D map monitoring and alarm, 3D map monitoring and alarm, Alarm, 4G signal strength storage, and Electronic fence data management system
- ATM consists of the Automatic ATM, UV control, and t planning and navigation database upload system

### (3) Government services

Government Service (G-Service) provides local government regulators with the safety supervision capability and level of UAV operation. At the same time, the G-Service can realize the statistics of UAV operation system and timely understand and control the operation of UAV. It mainly includes, UAV surveillance and alarm data services, and Data Statistics and Mining Service System

### (4) UAV operation service

UAV Operation Service (UOS) provides operational services for UAV operation process. The service platform includes not only collecting UAV-related information data, but also providing the following operational services, Aeronautical Information Service (AIS), Aviation Meteorological Service (AMS), UAV Performance Management (UAVPM), Airspace Plan & Management (AP&M), Flight Procedure Design (FPD), Navigation Database Management (NDM), Flight Plan Management and Report (FPM&R), User and UAV Registration (UUR), and Fly Self Service (FSS).

### (5) Data Value Added Service

Data Value Added Service (DAVS) mainly uses mobile 4G high-speed data broadband technology to achieve the transmission of UAV large data and third-party value added services. Taking into account the current existing UAV can carry high-definition mobile cameras, data value added service platform can achieve the following functions, UAV real-time video timely transmission and storage, and Other third-party data value added service system.

### (6) CloudStorage

CloudStorage uses mobile 4G cloud technology ONENET so as to achieve the operation and storage of large amounts

of data, and to ensure controlling the UAV operation process. It mainly includes,

- UAV-ATM platform business data storage: flight trajectory database, electronic fence database, alarm database, airspace planning database, obstacle database, navigation database, flight plan database, user and UAV registration information database, UAV performance database, 4D signal strength database
- And User business data storage: video, photos, and other aerial remote sensing equipment data.

### (7) Data Statistics and Data Mining

Data Statistics and Data Mining (DSDM) uses data mining technology to achieve UAV air traffic management process large data statistics (DS) and data mining (DM).

### (8) Information Safety Management

Information Safety Management (ISM) safely monitors the UAV air traffic management process to ensure that UAV air traffic management information platform system is security running. It mainly includes, the Mobile network security monitoring, the Operation data monitoring, the Burst information monitoring, and the emergency rescue monitoring and so on.

## 5. CONCLUSION

With the rapid development of China's national economy, civil small unmanned aerial vehicles called UAV, have been widely used in aerial photography, aerial mapping, traffic command, fire detection, fishing vessel monitoring, emergency rescue and so on . At the same time, due to lack of effective technical means and methods dealing , the UAV operation and management are not perfect g with dynamic understanding and master which resulted serious problem of global concern of the UAV safe operation. Based the concept of UAV, this paper firstly analyzes the development trend of UAV, and its existing problems from the aspects of UAV safety supervision system, supervision technology, information fusion and information security. Then based on the analysis of the technical characteristics of mobile 4G network technology, mobile computer technology and network technology, this paper puts forward the architecture of UAV-ATM information platform based on mobile 4G network, as well as the architecture of UAV-ATM information platform, as well as the functions of UAV-ATM information platform accordingly. And the eight sub-systems functions of UAV-ATM information platform are analyzed in detail respectively. The research work has reference meaning for realizing technical methods and the information

management of UAV, and promoting the safety supervision technology of UAV

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