Research on Low Altitude Platform Emergency Communication System based on airMAX

Zhuxin Zhang [a], Jiwen Hu [b]

School of Engineering University of PAP, Xi'an 710086, China

[a]839207650@qq.com, [b]18710724004@163.com

Abstract

Low-altitude platform relay communication has the advantages of rapid deployment, wide communication coverage and low maintenance cost, which is an effective means of regional emergency communication. According to the characteristics of the low altitude platform, the advantages of the platform in the field of emergency communication are analyzed by contrast with the platform of the high altitude floating relay. Based on the bandwidth and transmission distance requirement of low-altitude platform communication, the low- altitude communication platform based on airMAX is designed, the principle of airMAX and its polling scheduling system are analyzed. Platform single-base station, chain and surface networking scheme of emergency communication system, and gives the relevant conclusions.

Keywords

Airmax; Low Altitude Platform; Relay; Emergency Communication System.

1. Introduction

After the occurrence of major natural disasters, terrestrial communications network will suffer great damage, normal communication coverage can not be restored in a short time. The damage of the communication network has an impact on the emergency response, especially the transmission of broadband information that needs to transmit voice and video [1]. Maintaining the effective communication of the emergency scene communication system is of great significance to enhance the efficiency of emergency treatment.

At present, aerial platform relay communication is the main means to solve special terrain communication and emergency communication. The floating platform with floating equipment equipped with communication equipment as a space-based information platform, covering a wide range of emergency scenarios in a broad application prospects. The United States in 2005 proposed a Hurricane Katrina rescue HAPS communication program [2], to meet the needs of emergency communications. The system played an important role in the post-disaster reconstruction process, but it took at least two weeks to deploy in the early stages of deployment.

In this paper, a low-level platform (LAP) emergency communication system composed of tethered balloon and airMAX technology is proposed to overcome the high technical requirement, high investment and long time of high altitude platform deployment. It has high broadband transmission rate, System a wider range of communications coverage. For the field communication, emergency unit and command to provide effective communication between services.

2. Low-altitude platform features and advantages

The floating platform is a new kind of space-based information task platform based on aerial, which can be widely used in reconnaissance, early warning detection, electronic jamming, communication relay and other fields [3]. By flying or floating height, floating platform can be divided into high-altitude platform (HAPS) and low-altitude platform (LAP). Compared with HAPS, LAP has the advantages of rapid deployment capability and low loss, and is more suitable for rapid deployment of emergency scenarios. Specifically, LAP mainly has the following characteristics and advantages:

(1) High transmission quality, large network capacity

The use of LAP can be the existing cluster communication base station or VHF Repeater to a few hundred meters or even thousands of meters high, can effectively overcome the mountain, high-rise block and other shadow effect, so that each user terminal "see" Improve the signal transmission quality. And can carry various types of broadband communications systems, voice, video, data, large capacity transmission.

(2) Coverage area, low transmission loss

LAP-based communication coverage area is equivalent to several times the ground base station, and through a number of LAP network to further expand the communication coverage area; compared with the high-altitude platform, LAP space transmission loss, reducing the platform payload or ground The end-user's transmit power, thereby reducing system cost.

(3) Mobile performance, deployment of fast and flexible

At present, all kinds of tethered balloons after decades of development, its design, manufacture, use, maintenance technology has been more mature. LAP is designed to be simpler than HAPS, with a short deployment time and a wider deployment environment, highlighting the flexibility and flexibility of HAPS.

3. AirMAX introduction

AirMAX UBNT company is released in 2009, outdoor broadband wireless communications technology, the use of this technology can be achieved in the outdoor 150Mb / s TCP / IP transmission speed. The technology includes advanced radio hardware designs, base station MIMO antennas, and a powerful TDMA protocol that ensures speed and network scalability over thousands of meters of link.

The frequency modulation bandwidth is 3MHz, 5MHz, 8MHz, 10MHz, 20MHz, 25MHz, 30MHz and 40MHz, and the ideal frequency modulation bandwidth is 3MHz, 8MHz, 10MHz, 20MHz, 25MHz, 30MHz and 40MHz, the ideal air-frequency dynamic frequency transformation technology (DCF) Under the conditions of the maximum transmission distance of up to 232 km (bandwidth of 3MHz). AirMAX technology is a proprietary time division multiple access (TDMA) protocol, including TDMA slot allocation and polling scheduling technology. The airMAX equipment using advanced radio hardware and firmware combination, in support of airMAX technology TDMA protocol at the same time, through the mode of choice, to support the wireless LAN 802.11 protocol, which makes the use of airMAX device networking, you can use the support WiFi access Into the smart phone, the computer as a client terminal access backbone network, the client access threshold is lowered, easy network expansion.

4. AirMAX-based LAP emergency communications program design

4.1 Requirements analysis

Emergency situations, in a variety of means of communication loss of performance, the emergency communications construction needs to meet the following needs [4]:

(1) To achieve rapid deployment: network planning and deployment process must be simple and quick, and as far as possible without too much dependence on professionals, the configuration process as simple as possible.

(2) Convenience and portability: the rapid deployment of network requirements equipment operation process is simple, and the acquisition of equipment without a proprietary approach, as far as possible commercially available to buy.

(3) Robustness and Scalability: The terminal equipment of the emergency communication site must be in the change of the movement, the number of users is also changing, the network must have higher fault tolerance, can adapt to the environment change in time and the user Increasing the number of demand.

(4) Security: After the disaster, different rescue units to go to the scene, and there are some sensitive information, we must ensure the safety of information.

(5) Low-cost: network construction and maintenance costs as low as possible.

4.2 AirMAX key technologies and principles

4.2.1 Principles of TDMA protocol

Life is the most commonly used wireless LAN is to follow the IEEE802.11 series of standard WiFi technology, the hardware equipment cheap, easy to use and flexible. However, the MAC layer of WiFi uses the CSMA / CA (Carrier Sense Multiple Access / Collision Detection) protocol to allow the user to share the wireless network. In the case of a small number of users and a small collision area, the WLAN MAC layer has a good performance, and when the communication distance increases To a certain extent, will have a "hidden terminal" and other effects, affecting the quality of communication can not meet the needs of emergency communications within a few kilometers. Although WiFi uses the request-to-send / allow-to-send protocol (RTS / CTS) to avoid collision [5], collision is unavoidable when the user exceeds a certain amount and only applies to short-range wireless local area networks. AirMAX uses proprietary time division multiple access (TDMA) polling scheduling to improve the overall performance of point-to-point (PTP) and point –to - multipoint (PTMP) and noisy environments. It can effectively reduce the delay, increase the throughput, provide better tolerance, and prevent the traditional WiFi network in the "hidden terminal", multiple access "collision" and many other interference problems. Using the time slot allocation, so that each access to the client at a unified time scheduling, according to the time interval to send data to ensure that each client can be at the right time to obtain the same opportunities for communication, rather than Worry about collision avoidance. TDMA slot allocation principle shown in Figure 1 [6]:

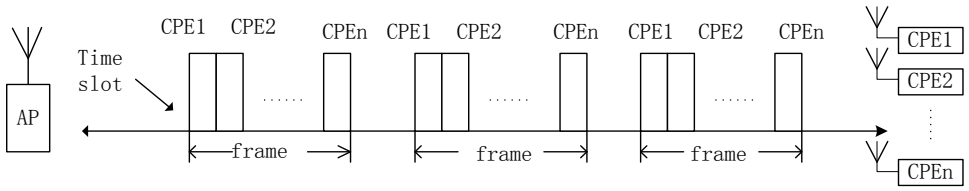

Fig. 1 Time slot allocation schemes of TDMA

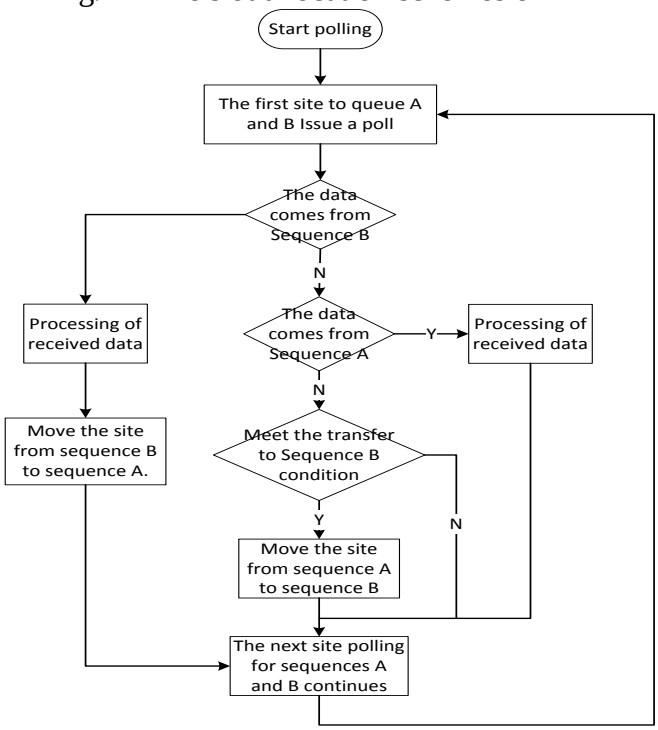

Fig. 2 Polling steps of TDMA

In a broadband wireless carrier, the time is divided into several frames, each frame is subdivided into a number of time slots, a time slot is a channel, assigned to a user. When necessary, it can adopt the way of "data aggregation" to combine multiple time slots into one large time slot to complete the transmission of emergency scene video.

The use of polling scheduling technology makes the time slot allocation more reasonable. The polling schedule diagram is shown in Figure 2.

First, two sets of active and lazy stations are set up. The polling information is sent down from the AP according to the set polling interval. Then, according to the principle shown in Figure 2 Complete the uplink data transmission and re-allocation of the station's own sequence. TDMA timeslot assignment adopts the method of rough estimation and precise management, which makes the allocation of active site and lazy site different, and then can divide the priority of the client. In emergency communication, priority setting ensures that the communication between the primary direction and the target is satisfied.

4.2.2 AirMAX the mesh networking

AirMAX does not have a unified network topology and node capacity constraints, so its networking can be changed as needed. Commonly used networking methods are chain mesh, point-to-multipoint and hybrid mesh networking.

Chain mesh network is a point to point, and then to the point relay network, as shown in Figure 3. In a chain mesh network, users can specify their neighbors in advance. The chain mesh is simple in structure and convenient in management. It is suitable for the long strip-shaped coverage areas such as the fleet and mine. However, because there is no branch and the link is single, any problem will lead to "chain breaking".

Fig. 3 Chain mesh network diagram

In a point-to-multipoint MESH network, all links are connected Central bridge equipment can be MPP (mesh floor node) or MP (pure mesh point), under special circumstances can also be MAP (node type mesh client). As shown in Figure 4, the point-to-multipoint MESH network, the wireless network all the data transmission through the MPP 1 to each other.

The MESH combination of point-to-multipoint is usually used for trunking trunking in cell coverage, trunking between buildings.

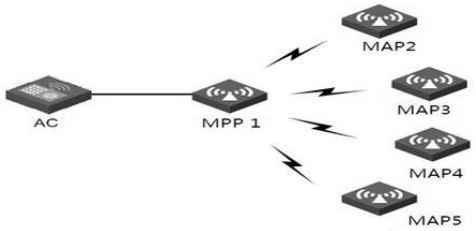

Fig. 4 Schematic diagram of the point-to-multipoint MESH networking

Residential wireless video surveillance systems and other occasions. With a large network coverage, the deployment of simple and rapid, easy to control and other notable features. However, because the MESH-assisted transmission requires loss of system bandwidth, it is only suitable for applications where the number of terminals is small or bandwidth pressure is low.

A number of chain MESH networks and point-to-multipoint MESH networks may constitute a hybrid MESH network. The hybrid MESH network is applied to various network environments that need to be optimized to improve the performance of bandwidth, coverage, and compatibility. It is suitable for emergency communication scenarios.

4.3 Based on the airMAX LAP emergency communication network program

From the above airMAX principle and the characteristics of low-altitude platform is not difficult to see that airMAX-based LAP communication system with emergency communications network to build the technical advantages to meet the emergency communications network should be a requirement: as the core station of the low-altitude platform can be set at forty Within minutes, the construction of the ground airMAX mesh network can be quickly deployed based on its existing equipment, without relying on the existing communications infrastructure; low-level platform applications greatly enhance the coverage area of the network to reduce obstruction of buildings and other obstacles ; And airMAX security mechanism is relatively complete, support WEP / WPA / WPA2 / WPA + WPA2 encryption, and MAC access address black and white list binding, 802.1 xRadius authentication, and DCF technology to further ensure the safety of the network, Anti-jamming capability; In addition, airMAX equipment sold at a lower price; its good network scalability can support the growing user for the emergency rescue to provide more support.

According to different network scale, LAP platform for the base station, low-altitude platform for emergency communication system is divided into single base station system and multi-base station system.

4.3.1 LAP single base station communication system

Single base station network is the basic use of the way, but also the most common way of emergency scene. The working diagram of its networking is shown in Figure 5.

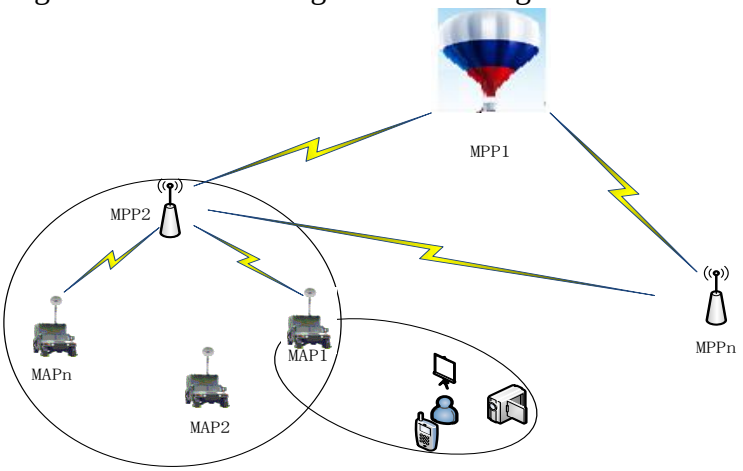

Fig.5 LAP single base station networking diagram

As shown in Figure 5, a single base station system consists of three parts: the wireless air network, terrestrial backbone network and customer network. (MPP2-MPPn), and the floating core node (base station MPP1) constitute a semi-fixed temporary wireless air network, the realization of the emergency network network construction, in a number of floating platform with good visibility conditions of high-rise buildings or high mountains on the site Remote transmission across city and mountain barriers; construction of a ground backbone network from a mobile vehicle site, setting the site as a reference AP relay mode, and opening a list of WDS sites to enable range relaying and connectivity with the subscriber network, a terrestrial backbone Equipment is mainly connected to the MPP2 or MPPn, conditions permitting with the base station MPP1 directly connected to complete the signal transfer; use airMAX equipment to build customer networks, can be 100-300 meters within the scope of WiFi coverage, and the use of the existing market a large number COTS products (smart phones, PC, PAD, etc.) as a user terminal to complete the collection of information. Using airMAX wireless mesh networking to build an emergency communication network, can significantly reduce the dependence on the communications infrastructure, and effectively enhance the viability of emergency communications.

4.3.2 LAP multi-base station chain communication network

When the emergency communication coverage requirements are more distant, according to the scale of emergency communications and protection of geographical distribution of the terrain into a chain communication network to determine the location of low-altitude platform set up. As shown in Fig. In the form of the connection shown in Fig. 6, the signal of the base station 1 can be relayed through the base station 2 to reach the position of the base station 3 to realize long-range low-altitude emergency communication.

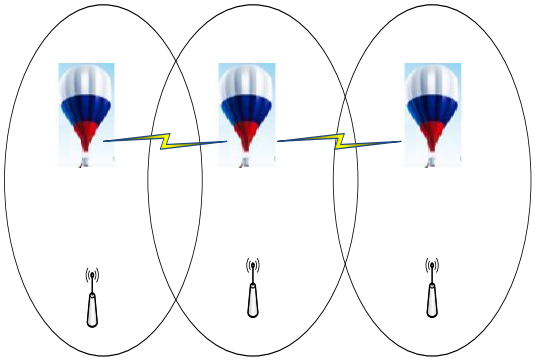

Fig. 6 LAP multi-base station chain diagram

4.3.3 LAP multi-base station surface communication network

When the emergency communications coverage requirements are extensive, according to the scale of emergency communications and protection of geographical terrain distribution into the form of surface communication network, to determine the location of low-altitude platform set up. In the form of the connection shown in Fig. 7, any mobile station communicates within the range covered by its base station, and it can communicate with another base station through the base stations to realize long-range communication with large area and long distance Communication.

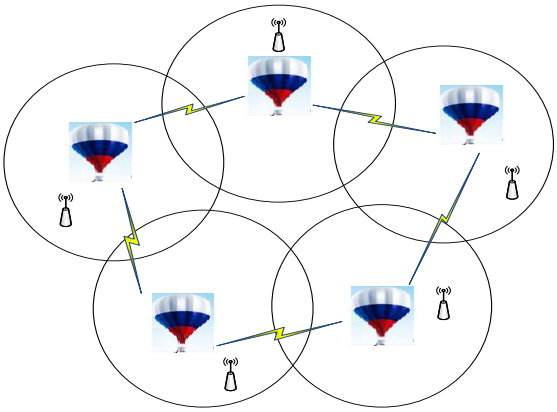

Fig. 7 LAP multi-base station surface network diagram

5. Conclusion

Based on airMAX low-altitude platform for emergency communications system with data transmission speed, transmission distance, high-quality communications, rapid deployment to support the terminal mobile and affected by the terrain and buildings of the characteristics and advantages of traditional communication networks can not meet the communication needs Emergency scenarios with broad application prospects. It can realize the real-time transmission of voice, data, images and video. The wide communication coverage is important for the interconnection of the emergency units and the accurate information transmission and command dispatching between the front and the rear, and providing technical support for emergency handling.

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