

Satellite Cooperative Communication

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Abstract: The joint operation under the condition of information technology is the main mode of operation in local warfare under the condition of high technology. Cooperative communication is the "nervous system" to maintain joint operation, which plays the role of cooperative command, cooperative action, operational effectiveness and overall combat effectiveness. As a key part of the military cooperative communication network, satellite cooperative communication has its own unique characteristics. This paper analyses the cooperative communication between different types of satellites, focuses on the cooperative communication between different types of satellites, and explores specific solutions.

1. Introduction

The construction of military cooperative communication network is an important part of national defense communication network construction and an important foundation of communication support capability. Satellite cooperative communication network has unique advantages that other communication networks can not match: satellite communication lines are relatively easy to establish, and can quickly establish global strategic and tactical communication network; satellite communication capacity is large, suitable for transmitting various forms of information; satellite communication is safe and reliable, anti-jamming ability is strong; satellite communication has the ability of broadcasting multiple access communication, can make satellite coverage area. With high mobility and flexibility, various terminals are connected into a network, especially in the communication distance and coverage area. In the future battlefield environment, the battlefield is sudden, fast, complex and changeable, and the battlefield situation is difficult to predict. Satellite cooperative communication network can adapt to the instantaneous change of battlefield situation, realize dynamic combination, and provide reliable communication support and guarantee for the whole army cooperative communication. This paper will analyze and discuss the existing problems and solutions of satellite cooperative communication.^[1]

2. Characteristics and Composition of Satellite Cooperative Communication Network

Any satellite communication system has a certain network structure, so that multiple earth stations can communicate through satellites in a certain way. The satellite communication network composed of several earth stations is usually a star network or a net network. In star network, each remote station can establish communication with the central station directly, but the remote station can not communicate directly through satellite. If necessary, it is necessary to transfer through the central station through satellite double hop to establish communication links. In a mesh network, communication links can be established directly between earth stations by satellite single hop. In addition, the network structure can also be a hybrid form of the above two networks, called hybrid network^[2]. In order to meet various communication needs, the satellite cooperative communication network is often a hybrid network structure which combines single hop and double hop.

Satellite communication consists of satellite communication systems such as strategy, tactics, data relay and broadcasting. In order to organize satellite cooperative communication network, we must rely on strategic trunk line communication, focus on tactical communication, assist with data relay and battlefield broadcasting information distribution system, and build a satellite communication platform with Space-earth interconnection, integrated services, fast and efficient.

The composition of the satellite cooperative communication network can be shown in Figure 1. Among them: the central station, regional station and base station are fixed stations; the airborne station, vehicle station, shipborne station and underwater station are mobile stations. The communication satellites shown in the figure can be strategic, tactical or data relay satellites, which communicate with each other using intersatellite lines (microwave or laser), with each fixed station communicating via ground trunk lines (optical fiber lines) and mobile stations communicating via wireless links (short wave, ultra-short wave, microwave or laser), so that each node in the network can achieve. The satellite cooperative communication network is constructed by interconnection and interoperability. The central station has a network control center and a key management center, which is responsible for the control and management of the whole network; the regional station is located in the communication command departments of various military and military categories and theatres; the base station is located in the communication hub of various military and military categories and theatres; and various mobile stations are allocated according to the command relationship.

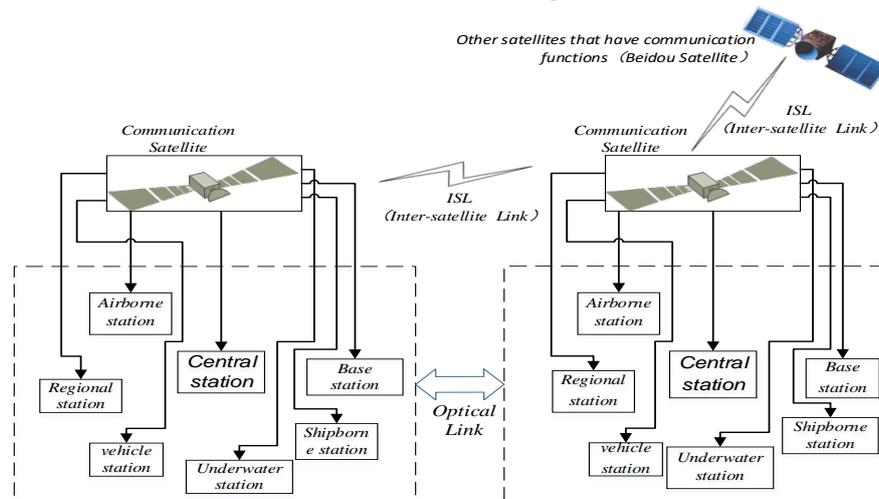


Fig. 1 Schematic diagram of satellite cooperative communication network

3. Analysis of Existing Problems

At present, the satellite cooperative communication network has not been fully realized, which directly restricts the information exchange and information sharing between networks, and affects the overall operational effectiveness of the satellite cooperative communication network. The main reasons are as follows:

2.1 Interconnection between Satellite Communication Systems

The broadband satellite communication network and narrowband satellite communication network in China are objectively restricted by their different object-oriented and communication systems. At present, there are many kinds of equipments in satellite communication system. These equipments use different satellites, different working frequency bands, various kinds of equipments, and their compatibility is not good enough. Moreover, the communication technology system supported by ground communication equipment is different, which directly affects the communication ability between devices and the ability to share satellite resources.

2.2 Interconnection between Satellite and Ground Communication System

The great differences between the basic characteristics of ground system and satellite system lead to the difficulties in their interconnection and interoperability. The first reason is that satellite communication network is not accessible to ground communication network signaling (such as SS7), which makes satellite resources can not be used by exchange. The second reason is the lack of consideration of the parameters and protocols required by the equipment in the ground communication system and satellite communication system. From a technical point of view, many

important national or international standards are mainly designed for ground communication equipment, and their performance on typical satellite links is still insufficient.^[2]

2.3 Interconnection of Different Types of Satellites

At present, in addition to dedicated communication satellites, there are other types of satellites also have certain communication functions, but there are still some institutional and technical problems in their interconnection. For example, the Beidou Navigation Satellite Network, which is built independently in our country, has already possessed the network function. Besides the navigation function, it also has certain communication function (short message): short message single communication ability of 14000 bits (1000 characters) in China and its surrounding areas, and global short message single communication ability of 560 bits (40 characters). However, there is no direct communication between different types of satellites, which makes the efficiency of satellite cooperative communication greatly reduced and the joint efficiency can not be fully developed.

The existence of these problems makes the communication of the whole army cooperative operation not real-time, and affects the access of satellite communication network and tactical Internet. For example, in special emergency situations in wartime, if the senior commander located at the trunk node (broadband satellite network coverage) needs to know the real-time combat situation of the front-line combat unit (narrowband satellite network coverage), because it can not communicate directly, it can only contact the front-line unit command post by other means, thus delaying fighter planes and affecting cooperative operations.

3 Discussion on Solution Measures

To solve these problems, we need to start with the standardization of interfaces and the transformation of network protocols, develop or adopt new standards and protocols, and then consider some non-technical factors. After referring to ITU-T relevant suggestions on network interoperability and thorough investigation, the author puts forward the following methods:

3.1 Using Unified Interface Standards

For example, the ITU-T Q.768 standard is used, which is the signaling interface standard between the International Terminal Authority and the satellite network. The basic function of Q.768 signaling is to inform the earth station when the trunk circuit is put into use. Once there is an access request, the satellite system chooses a free band link and connects the trunk circuit at both ends. This architecture provides higher system utilization with lower congestion rate. Q.768 allows the exchange center of the international junction bureau to interact with the satellite service terminal, and Q.768 does not belong to SS7, so there is no need to make any changes to the existing signaling network.^[3]

3.2 Using Protocol Converter

Protocol converter mainly completes protocol conversion and information forwarding, and plays the role of transmission service gateway and routing. For the interconnection of ground equipment, a special transmission server can be set up between the two networks to achieve uninterrupted and seamless routing between different standard networks. For inter-satellite interconnection, inter-satellite links are required to transfer protocol converters from the ground to the satellite.

For example, assuming that the Beidou short message protocol conversion module is added to the conventional communication satellite to enable it to communicate with the Beidou satellite network (as shown in Figure 1), the problems of limited resources of communication satellite, satellite communication between different orbits and emergency communication will be solved to a large extent. Although the communication capacity of Beidou short message is limited, it can be used as an emergency or standby means for emergency communication and rapid reporting of military emergencies, which can improve the ability of rapid response and command decision-making in emergency rescue and military emergencies. More importantly, the basic products of Beidou system have been controlled independently, which improves the reliability and security of military communications, and is of greater significance.

3.3 Other Questions

In order to establish a satellite cooperative communication network, besides following the principles of interface standardization and network protocol consistency, the following key organizational relationships and institutional issues must be solved:

(1) Establishment of leading bodies and unified planning and Implementation

Satellite cooperative communication network is a huge and complex system engineering, and an important part of national defense communication network. Its establishment should be unified planning, hierarchical construction, and overall design should be done well from the reality of joint operations. Firstly, the leading units should be established and considered as a whole. Their functions should include: 1) overall planning, macro-control, organizing communication networks from a global perspective, coordinating the connection of communication systems of all military and military services participating in the war, and implementing overall support; 2) rational allocation of communication facilities in theatre so as to make full use of communication resources; 3) scientific management of battlefield spectrum, rational allocation of spectrum resources; improving EMC Quality.

(2) Establishment of a reasonable cooperative communication force

At present, in our military communication network, each military branch has its own system, is relatively independent and lacks unified interface capability, which brings difficulties to cooperative communication. Moreover, there is no special cooperative communication support team, and it is difficult to support training or wartime cooperative communication needs, and it is difficult to meet the needs of joint operations. Therefore, it is particularly important to set up a reasonable cooperative communication support team.

(3) Developing new cooperative communication equipment

On the one hand, we should pay close attention to the development and production of new equipment, on the other hand, we should actively upgrade the old equipment. The development of cooperative communication equipment should be divided into two steps: the first step is to break the boundaries of military and military categories, conduct comprehensive tests with existing equipment, select high-quality equipment, first determine a set of temporary cooperative communication equipment, and establish a flexible satellite cooperative communication network; the second step is to use advanced technology to develop new cooperative communication equipment, and unify the establishment of military-wide interoperable, three-dimensional coverage satellites. Cooperative communication network can truly achieve the serialization and standardization of cooperative communication equipment^[5].

(4) Research on on-board switching technology

In order to interconnect earth stations working in different beams, different frequency bands and different satellite coverage, on-board switching network control technology is the core. According to different communication systems, different working modes and different business characteristics, the optimal on-board switching structure is studied to enhance the satellite network control function. At the same time, it is suggested that at the beginning of the design of the software and hardware platform of the system, we should consider not only compatibility with the existing system, but also whether we can support the new system. For example, on-board software can be overloaded, and some exchange interfaces are reserved on-board to prepare for compatibility with the new system^[2].

(5) Research on Constellation Design Technology

Constellation design is the primary problem in satellite communication system design. With the increasing number of satellites, the integration and unified management of satellite resources is particularly important. In view of the requirements of our army's cooperative communication and future development, we should adopt the design idea of global coverage, make use of the optimal design results of Walker and Ballard constellations, and combine our army's specific conditions to realize the continuous coverage of our army's joint operation theatre^[4].

(6) Strengthening the Destruction Resistance of Satellite Cooperative Communication Network

In large-scale joint operations, satellite cooperative communication network will be threatened by both electromagnetic interference and fire destruction of the enemy due to the competition for

sky-making power and the natural vulnerability of satellite platforms. Therefore, the satellite cooperative communication network must adopt advanced anti-jamming communication equipment and adopt dynamic network topology. After some nodes or links fail, the network can continue to maintain its own functions. At the same time, we should actively develop anti-destructive technologies or measures, such as developing small satellite clusters, developing stealth satellites, nanosatellites, or establishing an army for active defense^[5].

4 Summary

Since the establishment of satellite cooperative communication network is a huge system engineering, it is impossible to cover all aspects mentioned in this paper, and inevitably there are some inappropriate points. It is believed that with the continuous development of technology and the continuous exploration and efforts of our relevant departments, the satellite cooperative communication network will be increasingly perfect and become an integral part of the whole army cooperative communication network, further improving our army's communication capability in joint operations.

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