Development and Research of Airborne Network Communication Technology

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Abstract: With the continuous development of data bus communication technology and computer technology, avionics equipment put forward higher requirements for airborne data communication bandwidth, data throughput, real-time, reliability, security and so on. Avionics system is the "brain" and "nerve center" of aircraft, and airborne data bus is its key "neural network". In this paper, The development of airborne network communication technology is introduced, and the application of FC optical fiber switch structure network in aircraft avionics system is described, the airborne network communication technology of avionics system is analyzed and discussed in different stages of use, and it is pointed out that FC optical fiber data bus communication network will be widely used in the field of avionics system communication in the future.

1. Introduction

The avionics system of modern fighter is the result of the long evolution and continuous progress of avionics technology over half a century. With each change of avionics system, the core of airborne bus communication technology is also constantly stepping onto a new level, and each change has greatly improved the performance of the aircraft. The flight and combat tasks of modern aircraft include take-off, cruise, flight control, target search, identification and tracking, fire control calculation, weapon projection, guidance, electronic warfare, communication, etc. all need to be undertaken by the avionics system, which is the "brain" and "nerve center" of the aircraft, and the airborne data bus is its key "neural network".

2. Development of Airborne Network Communication Technology

The development of airborne network communication technology is closely related to the development of avionics system, from the ARINC429 data bus used in the initial discrete avionics system, to the MIL-STD-1553 data bus used in the joint avionics system, to the AFDX and FC used in the integrated avionics system; each change of airborne communication network is In order to meet the development requirements of avionics system for airborne data communication bandwidth, data throughput, real-time, reliability, security and other aspects, several typical data bus networks are described below [1].

Especially in the deep and highly integrated avionics system in the future, it is more necessary to collect a large number of internal and external data of the aircraft, and integrate them to form a correct perception of the battlefield environment, so as to realize the intelligent control of the aircraft and weapon system. The space-space network war poses a new challenge to the airborne network.

2.1. Arinc429 Data Bus

ARINC429 data bus is an interface oriented data transmission structure. The transmitting and receiving devices are defined on one bus. The number of transmitting devices must be one, while the number of receiving devices is generally no more than 20. The schematic diagram of data bus

network structure is shown in Figure 1. The data bus network architecture of aircraft avionics system is built by the data bus. The sending and receiving end are some sensors, controllers, displays and special analog computers. The transmission of this digital signal is realized by twisted pair between the equipment.

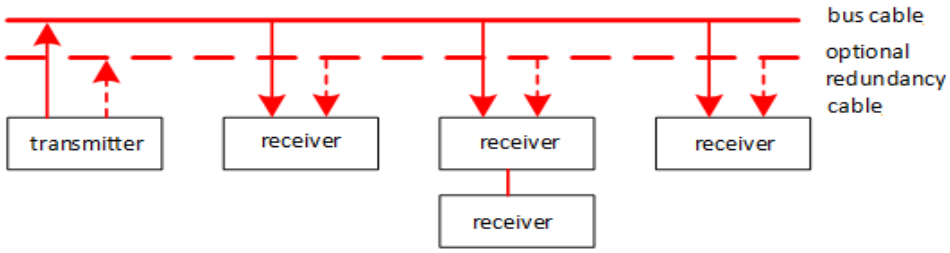

Figure 1 Network structure of ARINC429 data bus

ARINC429 Bus standard provides two kinds of transmission rates. For the terminals with small amount of data, such as sensors, actuators, control panels, etc., the transmission rate is usually 12-14.5kb/s at low speed. For the terminals with large amount of data, such as computers, the transmission rate is generally 100 kb / s at high speed. At the same time, ARINC429 data bus information flow is only transmitted in one direction, that is, from When the signal source reaches the end, the receiving end cannot confirm that it has finished receiving. When the bus is available, the signal source sends the message [2]. When the information is transmitted, the receiver must receive it. The sender does not know whether the receiver has received the information accurately. For information loss or error, ARINC429 Bus has no handset control and error correction mechanism.

2.2. Mil-Std-1553b Data Bus

MIL-STD-1553B data bus is a bi-directional, linear topology, centralized control, command / response protocol bus. The communication devices on the bus can be divided into bus controller (BC), bus monitor (BM), remote terminal (RT) according to their functions. The bus controller is responsible for the transmission of information tasks on the bus. The bus monitor receives the information on the bus for future use. Other terminals on the bus are remote terminals. The schematic diagram of data bus network structure is shown in Figure 2. The network architecture of avionics system bus built by the data bus is layered by system functions, such as radar, navigation, flight control, fire control and integrated display, and each subsystem is linked by MIL-STD-1553 data bus.

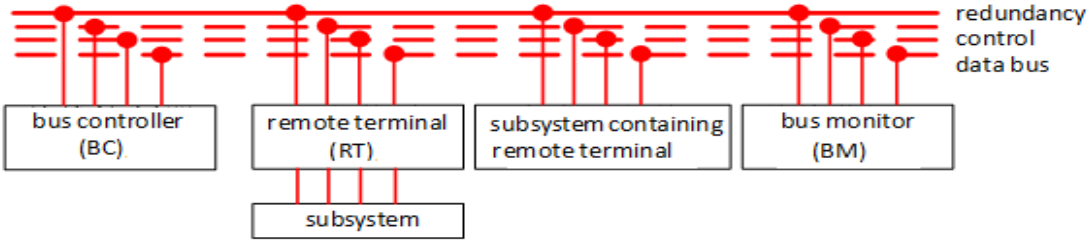

Figure 2 Network structure of MIL-STD-1553B data bus

The MIL-STD-1553B data bus uses the Manchester bipolar encoding format with a transmission rate of 1Mb/s. The bus is controlled by the central bus controller, which is embedded in the remote terminal of LRU. Each transmission is realized by a fixed form. First, BC sends instructions, RT outputs the transmission, and then the received RT gives a response. This form of communication has a high degree of certainty, and a wide range of message error detection and correction capabilities enable the transmission data to have a high degree of integrity. However, the bus communication network built by MIL-STD-1553 data bus has some limitations, such as the lack of bus bandwidth, the need for multiple buses, the low degree of sharing hardware and software resources, the very limited fault tolerance, the low degree of standardization, the need for intermediate level maintenance and the high cost of life cycle.

2.3. Airborne Switching Network

With the improvement of the integration degree of the integrated avionics system, the system puts forward higher requirements for the data throughput, speed and delay of the communication network. A new interconnection scheme based on the data network communication is proposed, which has the advantages of high real-time, high reliability, high bandwidth and high cost performance. The emergence of AFDX (Avionics Full duplex Ethernet switching network) represented by foreign Airbus A380 and Boeing 787 aircraft, and FC communication technology represented by F-35 aircraft have successfully equipped the aircraft, which provides the network communication foundation for the integration of avionics system of the aircraft, specifically reducing the interface, connector, transmission medium and testing instrument And the type of equipment, cancel the protocol conversion, so as to save the development cost of hardware and software, reduce the requirements of maintenance. Domestic aircraft manufacturers are also vigorously promoting AFDX and FC bus communication technology in the development of new aircraft [3].

AFDX network is a kind of star network with switch as the center, including terminal and switch. The terminal system is connected to the switch through full duplex link, while the internal equipment is connected to the main equipment of each subsystem through parallel bus. The connection medium adopts two pairs of twisted pair wires independent of each other for receiving and transmission. The terminal system and switch are connected according to the specified communication list configures the message transmission mechanism, establishes the virtual link and the time slot bandwidth allocated by the bandwidth through the network, and ensures the determinacy of the point-to-point data communication delay. The network supports 10MB / s and 100MB / s transmission rates, meets ARINC653 Avionics Communication software design standard, and supports SAP software communication interface.

FC optical fiber network is an interconnection scheme different from the traditional channel and network structure, which is proposed by the concept of computer channel and data network. It is an open communication technology with high real-time, reliability, bandwidth and cost-effective. It uses channel technology to control signal transmission, exchange or arbitration ring to deal with media access conflict, and credit strategy to control network flow Quantity. FC network defines three basic extension and complement structures: point-to-point, arbitration ring and switch structure. The switch structure is a widely used extension and complement structure, and the schematic diagram of network structure is shown in Figure 3. The transmission rate of network support has reached 4GBIT / s, and is developing to 10Gbit / s. FC optical fiber network and channel transmission support a variety of physical media such as optoelectronics, which can provide communication services of different quality and bandwidth, as well as support a variety of high-level application protocols such as SCSI, IP, ATM to meet different communication needs.

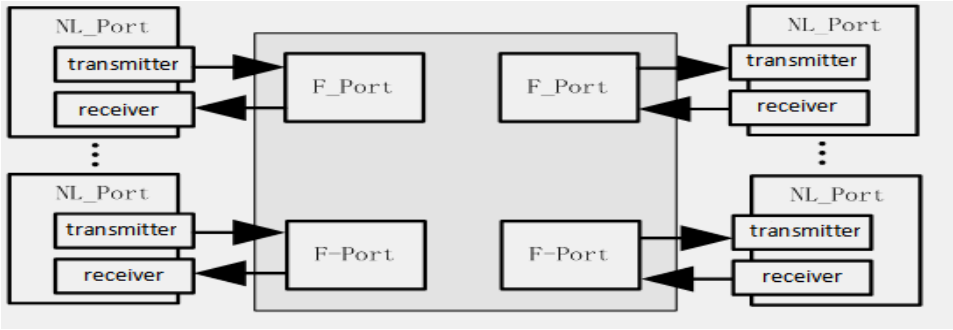

Figure 3 FC optical fiber network structure

3. Application of Fc Optical Fiber Switch Structure Network in Aircraft Avionics System

A unified avionics interconnection network scheme, represented by the Joint Advanced Attack Technology Program of the United States, is proposed. The integrated core processor, integrated sensor system (including integrated RF sensor and integrated photoelectric sensor), aircraft management system, pilot / aircraft interface are connected through FC optical fiber network. Jast is

the representative of the aircraft mission system network as shown in Figure 4, data communication between avionics system equipment is realized through high-speed data bus, which changes the data transmission mode of signal format conversion between systems, reduces system cost and improves system reliability. The fifth generation fighter of the United States realizes the functional integration of four-dimensional navigation, flight control and engine thrust integration, fire control and flight control thrust integration, video infrared and radio sensor integration and other subsystems through FC optical fiber exchange structure network. At present, the advanced fighter has widely used FC optical fiber network for data communication, with long transmission distance, high speed, low bit error rate and signal It has the advantages of small delay and strong anti-interference ability. At the same time, the integrated management of avionics system also has significant development. The pilot interacts with the flight management software through assistant software and situation awareness system. The flight management software interacts with the flight manager and fire control software to control the work of each subsystem.

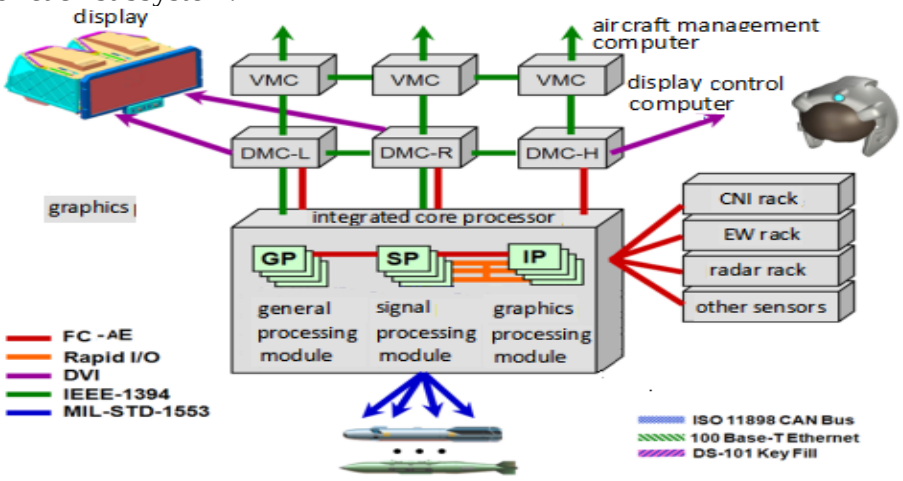

Figure 4 Network structure of aircraft mission system represented of JAST

4. Conclusion

With the increasing integration of avionics system, the increasing memory capacity, the faster processor speed, and the large amount of data transmitted between the devices on the aircraft, all of these pose new challenges to the signal transmission between the systems on the aircraft. FC optical fiber communication network has been widely used in various fields of civil and military products since its development. Compared with other mature bus technologies, FC fiber bus has incomparable advantages in transmission rate, transmission distance, transmission delay and communication error rate. However, the research and application of FC fiber-optic bus in domestic aviation field started late, and the specific application scheme is less. With the passage of time and the continuous accumulation of domestic related technologies, it is believed that FC optical fiber bus will become the first choice of data bus on the new fighter.

References

[1] Xiaobo Pu. Modern avionics system and synthesis. Aviation Industry Press, December 2013

[2] Wei Cong, fan Xiaoguang, nanjianguo, general technology of integrated avionics system, National Defense Industry Press, January 2015

[3] Chaoyou Zhi. Qin Cheng. Aircraft avionics system. National Defense Industry Press, October 2015