Research and Simulation Implementation of communication configuration algorithm for avionics system

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Abstract. In view of the current avionics system especially the communication configuration information model of avionics system based on AFDX bus accessing difficulties, and the aircraft needing to change the manual for rectification, by summarizing the characteristics of AFDX network bus and end system in the communication of A380 avionics system, a communication configuration algorithm for airborne electronic components is proposed. First, the XML model of the algorithm is carried out, then, the configuration information in the manual is written in the XML document and finally, the XML document is parsed and run through the C++ program, reproducing the communication process of aviation electronic system. The results show that the proposed algorithm can accurately describe the communication configuration of avionics system, and the model has laid a foundation for the realization of the automatic configuration of the avionics system manual.

1 Introduction

With the development of modern aviation electronic technology, Avionics system is more and more complex and there is a large amount of data needs to be exchanged between the various systems. At present, the communication information of aviation electronic system is obtained by referring to the relevant aircraft, this approach can only be mastered by skilled workers and time-consuming, laborious, but also very easy to make mistakes. When the aircraft occurred, the need to modify the configuration information in the manual. In recent years, AFDX (Avionics Full Duplex Switched Ethernet) as the main network of the Airbus A-380 successful application is increasing the complexity of the communication process of avionics components, which needs a new algorithm to describe the communication configuration of the avionics system.

In this paper, we propose an algorithm for the communication configuration of avionics, and based on XML to model it. Based on this model, the system is configured, The configuration of the XML document by C++ platform, operation analysis, reproducing the communication process of aviation electronic system.

2 Communication process analysis of A380 aviation electronic system

Network characteristics. A380 backbone network is based on the ARINC664 protocol of the full duplex switched Ethernet (AFDX) bus, in the use of twisted pair connection, and transfer data rate is 100Mbps[2]. The main components of the AFDX network are shown in Fig. 1, including the switch (Switch), the end system (End-System, ES), and the transmission link (Link).

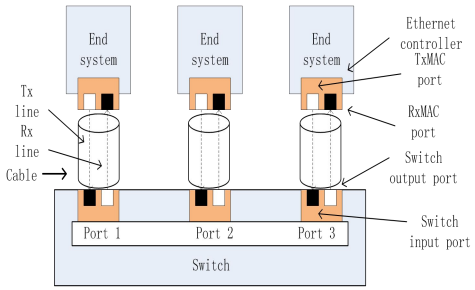

Figure 1. AFDX bus network diagram

The switch is in the core position in the AFDX network communication, which is responsible for the frame filtering, traffic management and data forwarding in the network. The link is a physical path for connecting the end system and the switch, which can be used as a transport medium for copper or optical fiber. The end system is the interface device for the avionics subsystem, which is an important component of the AFDX network. It is embedded in each avionics subsystem, which is connected with the AFDX network, which is responsible for sending and receiving messages.

Communication process analysis of equipment and system. From the point of view of avionics, ES provides different data transmission modes through two types of ports: the communication port and the SAP (Access Point Service) port[3]. Fig. 2 describes the communication processes of the two devices and one end system. Each device has an IP address.

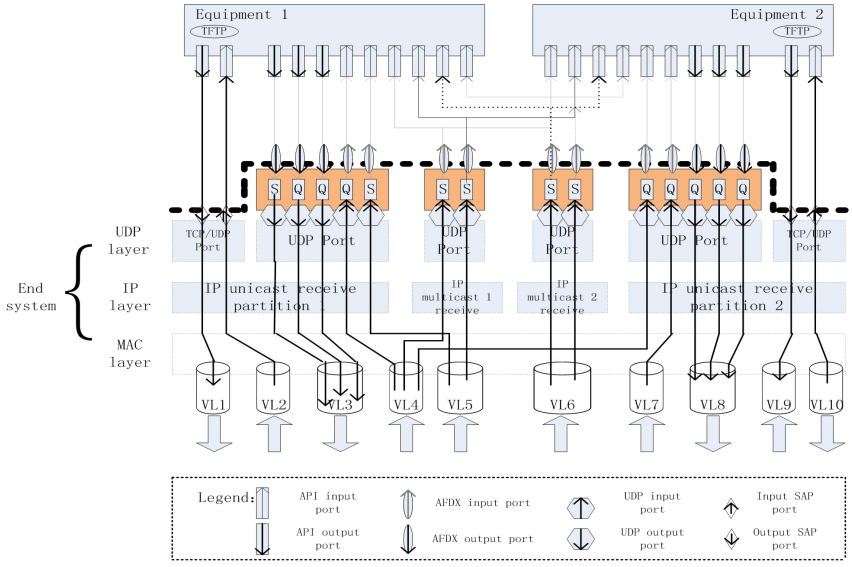

Figure 2. the interface between the device and the end system

ES provides two types of services through communication port: sampling (sampling) and queue (queuing). Due to the relatively high efficiency of UDP, two kinds of services are using UDP communication. According to the provisions of 2.3.5.6.1 ARINC653, the request of the sampling service to the sending end: sampling service must be based on multicast and one-way communication; sampling service docking port: the last information stored in the sampling port must be capable of being read by a plurality of applications (i.e., a plurality of port access to the same sampling port). According to provisions of the ARINC653 2.3.5.6.2, service queue to the sending end requirements: when the send buffer overflow, the error signal must be sent to the sending application, send frames are discarded. The queue service is required for the FIFO: the data in the queue can be passed to the application only after the reorganization, and when the receiving end buffer is over, the error message must be sent to the receiving application and the receiving frame is discarded.

SAP port is used for data communication between AFDX network. As a part of the system design, it can access other networks through gateway or router; The end system can provide the maximum support for 8K byte data communication for UDP services and a compatible network for communication; The difference between the SAP port and the queue port is that the use of the SAP port can define the destination address of the IP and the destination address of the UDP[5].

3 Algorithm and Implementation

3.1 Configuration algorithm. In fact, the communication of the avionics system is the information transmission between avionics, so the configuration of the avionics system is the configuration of the avionics. In this paper, the communication configuration algorithm is shown in Fig. 3, for an avionics, the corresponding communication configuration steps are as follows:

1) equipment name and ID;
2) port configuration.

Port configuration steps are as follows:

1 Port under the switch and end system;
2 port number, port transmission of data types and transmission Direction;
3 port data transmission mode;
4 configuration of VL, Sub-VL and data.

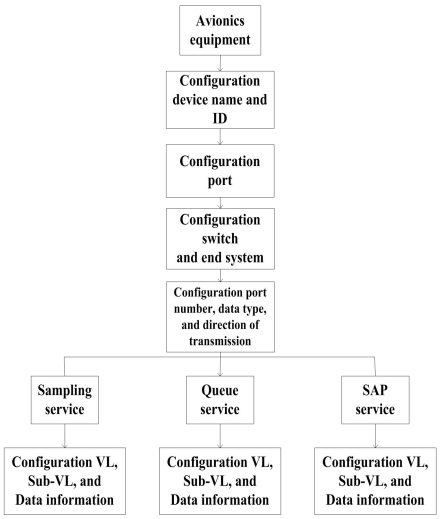

Figure 3. communication configuration algorithm

3.2 Algorithm XML modeling. Extensible markup language XML (Markup Language Extensible, referred to as XML) is a standard language for data transfer and exchange of World (Wide Web Consortium W3C (W3C) organization, the latest version is the organization's two edition in April 2013.As a standard (Generalized Markup Language (SGML) SGML SGML, the XML is the main function of the Standard, while the complexity of the SGML is greatly reduced[1]. XML is independent from any language and architecture, providing a loose tree structure suitable for representing semi-structured data, and has the characteristics of strict definition, clear structure, flexible and easy to read, can be used to describe the complex information. It has become one of the most widely used data exchange and storage format in computer system.

XML modeling, that is to create a model describing the structure of the XML document, commonly used to define the language of DTD and schema, the selection of schema XML modeling, schema visualization, in order to facilitate a clear understanding of the structure of the model tree[7]. One of the principles of XML modeling, the separation of information as far as possible

separation[6]. According to this design concept, the XML modeling scheme is shown in Fig. 4, and the configuration of the avionics system is divided into the configuration of the device.

The configuration of the device includes the configuration of the device information and the port, and the configuration of the port is composed of the port information (including the switch and the end system), the port information (including the port number, the port type and the transmission direction) and the service information which is used in the port, The service information includes sample service, queue service and SAP service. The sample service is an example, the configuration of the sample service includes VL, Sub-VL and data information.

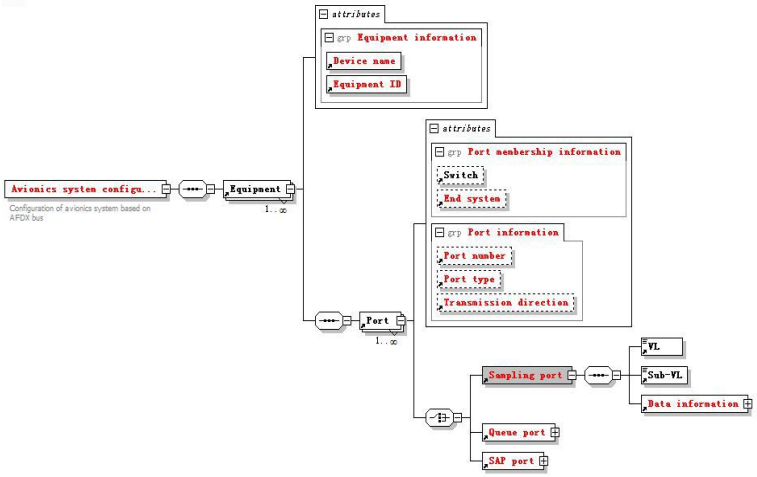

Figure 4. communication configuration algorithm modeling

4 Software implementation

4.1 Program flow. This paper is based on the Windows platform for XML communication configuration model for the simulation, which the process is shown in Fig. 5. First, we will analyze the XML document according to the configuration model, and use the API DOM to analyze the document, and make the XML document into memory, and then the document is parsed, according to the definition of elements, attributes, notes, etc, which creating a document object model in memory by using the structure tree. Here is actually the document object, each node in the document corresponds to the model of an object, and then according to the object provided by the programming interface[4], in the process of accessing the object in the application process, the communication process is realized.

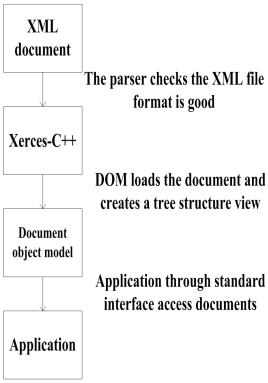

Figure 5. XML communication configuration model simulation process

Procedures in the running process of the document object traversal, traversal process followed by the rules of the device node in order to access, access to the device, including the use of all ports to access the port, the port is used to determine what kind of service to use, and to take different

types of services to different procedures. Fig. 6 and Fig. 7, respectively, for the procedures for sampling services and the queue service procedures, SAP services and the procedures of the queue service is similar to the procedures, where no example.

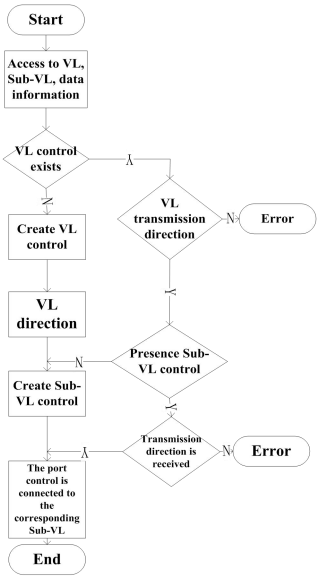

Figure 6. sampling port program

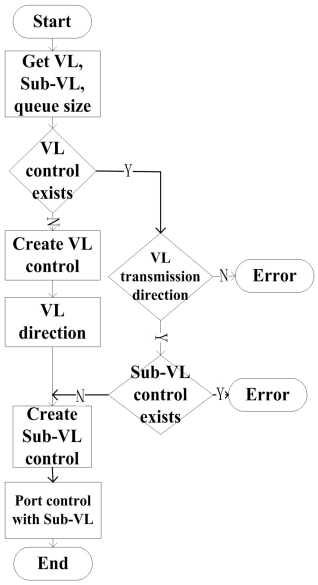

Figure 7. queue port program

4.2 Simulation verification. According to the CHARACTERISTIC 712-7 AIRBORNE ADF SYSTEM ARINC manual, there are 65 channels in the ADF receiver, which divided into several types of channels, including the main ARINC429 channel, discrete channel and analog channel, there are many empty channels. From Table 1, there are four interfaces of ADF receiver and ARINC429 channel in 65 channels, and from Table 2, there are two interfaces of ADF receiver and discrete channel in 65 channels.

Table 1. ADF receiver and ARINC429 channel interface

Name	Pin position	Direction
Freq/Funct Select Data Input Port A	MPB4	Input
Freq/Funct Select Data Input Port B	MPB7	Input
Bearing Output Number 1	MPB10	Output
Bearing Output Number 2	MPB13	Output

Table 2. ADF interface and discrete channel interface

Name	Pin position	Direction
Ground/Air Logic	MPB15	Input
Source Select Discrete	MPB3	Input

In the ADF receiver port configuration information, the frequency / function data input A and frequency / function selection data input B information transmission is set to the same VL, the ADF azimuth output 1 and ADF azimuth output 2 transmission is set into the same VL, and different types of channels will be used to set up different end systems. Configuration of good XML document by Xerces-C++ analysis, and then run through the program, the final figure 8, the process described in line with the manual.

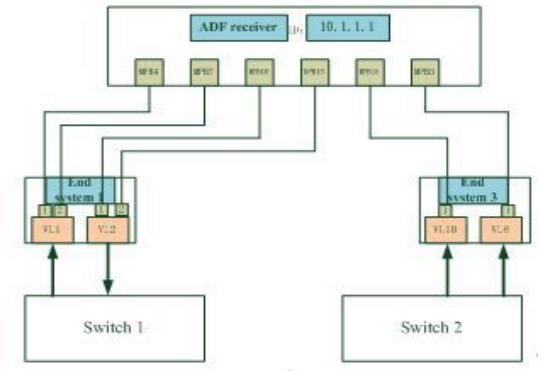

Figure 8. program running results

5 Conclusions

For the problem of communication configuration information accessing in aviation electronic system, in this paper, by studying the communication process of A380 avionics system, and proposing a method of communication configuration, the algorithm is based on XML model. The simulation of the algorithm model is carried out by C++ program, simulation results show, the proposed algorithm can accurately describe the communication configuration of avionics system, and the program can reproduce the communication process of avionics system. It is the basis for realizing the automatic configuration of the electronic system manual and a way to realize the automatic identification of the avionics system components.

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References

[1] Marcjan R, Siwik L. The Concept of Transformation of XML Documents into Quasi-Relational Model[M]//Beyond Databases, Architectures, and Structures. Springer International Publishing, 2014: 569-580.

[2] Hamza T, Scharbarg J L, Fraboul C. Priority assignment on an avionics switched Ethernet network (QoS AFDX)[C]//Factory Communication Systems (WFCS), 2014 10th IEEE Workshop on. IEEE, 2014: 1-8.

[3] Li Z, Li Q, Zhao L, et al. Openflow channel deployment algorithm for software-defined AFDX[C]//Digital Avionics Systems Conference (DASC), 2014 IEEE/AIAA 33rd. IEEE, 2014: 4A6-1-4A6-10.

[4] Yu Xiaojuan, Ran Jing, Li Aihua, etal. based on XML DOM analysis and application of [J]. computer technology and development, 17, 2007 (4): 86-88.

[5] Zhao Yongku, Li Zhen, Tang Laisheng. AFDX network protocol of [J]. computer measurement and control, 2011, 19 (12): 3137-3139.

[6] Wang Han, Shen Subin, Wang Xiaojun. XML modeling technology [J]. Journal of Nanjing University of Posts and Telecommunications: Natural Science Edition, 2006, 26 (1): 42-47.

[7] Chen Guangzhi, Li Lei. Visualization method of process information based on XML and its implementation [J]. computer engineering and design, 2015, 4: 19.