Research of Subway's Train Control System Based on TCN

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▶ To cite this version:

HAL Id: hal-01564884
https://hal.inria.fr/hal-01564884

Submitted on 19 Jul 2017

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Abstract：Contraposing the subway car control equipment being scattered, the subway train controlnetwork system based on TCN RTP is designed. By constructing the virtual network environmentnetwork with simulation software NS2 and writing message data of transmission layer protocols.Through testing train control network communication efficiency, the influent factors of communication efficiency is known.Train control telecommunications devices based on TCN RTP communication function is developed.Using XML technology and JAVA language JDOM analytical mode, the compatible TCCL cross-platform configuration software of other train control communication equipments is designed.Through the train control communications equipment configuration of the basic functions and setting device configuration of network communication operation parameters to the purpose.

Key words:TCN ;RTP ;Event arbitration ;Network simulator

1.INTRODUCTION

Train network control system is a set of distributed computer system,winch carries the information of control, test and fault diagnosis by the train's bus, monitors all trains and cars of related functions [1].The railway signal has been changed . The traditional way is the ground signals to pass traffic command, rules of operation of drivers. At present ,the way is that the information be sending by the line under the ground automatically controls train speed and the car running by the control system in a controlled manner.

In order to achieve the coordination of the dispersion trains of equipment in all vehicles,train communication network gradually is developed in the early stage on the basis of serial communication bus .

But trains production companies around the world use different train communication network technology in their respective development manufacturers, and the signal system is different.The importing subway train of our country have also used various types of train communication network, such as the Shanghai Pearl Line Metro uses the WORLDFIP bus and Guangzhou Metro Line 1 uses vehicle bus based a high-level data link control (HDLC) protocol[2-3]. The major cities are being connected the different train's network.

Network control is a way that control scattered train control equipments, so network controlling the control device of train control system is out of natural selection and necessary requirement,which has important theoretical significance and application value to actively promote the localization process of train control technology .

This paper mainly reseach the following issues of subway train control system and communications network based on TCN.

（1） RTP (Real-Time Protocol) packet transmission and verification.The data communication frequency and message priority between the Multifunction Vehicle Bus (MVB) and Wire Train Bus (WTB) are different, research transmission Methods of three types of real-time information:process data, message data and monitoring data in the TCN network.

（2）Train control communications network performance. Setting up the TCN test environment to analyze factors of the network operation performance ,such as loss rate of the network node information packet, delay and jitter rates.

（3）Achieve train control device configuration capabilities.Select the structure and design of configuration file markup language to complete the basic functions of control equipment, network topology, to achieve device configuration.

2.RTP communication modeling

RTP communication model uses the publisher / subscriber communication structures. IEC 61375-1 defines the statute of the corresponding abstract model RTP, which services in the train control system. MVB and WTB transmission three types important information of process data, message data and monitoring data, which is a cycle process of data communication mode compared with sporadic transmission message data.

The transmission of RTP messages uses by the master scheduling mechanism. General Event uses by the polling way. When more than one device requests to respond ,it will collide, then the bus master boots arbitration mechanism. Event arbitration is distinguished by event priority to achieve efficient incident response.

Because the frequency of data communication and message priorities between MVB and WTB are different, the paper focuses on the methods to transmit of the three types of real-time information in the TCN network.

(1) Messages transmission mapping of RTP model achieve more specific.The application layer protocol data unit is specifically defined as PDU (Protocol Data Unit),which is coded by the presentation layer, then directly map to the data link layer and physical layer.Namely the transport layer and network layer are empty. The purpose of this mapping is to avoid the propagation delay caused by communication stack, thus ensuring the rapid transfer of packets.

The role of presentation layer is encoding the application layer PDU to fit transmission in the TCN network, RTP message transmission encoding selects using ASN.1 Basic Encoding Rules (BER).The flowchart of codec is shown in Figure 1.
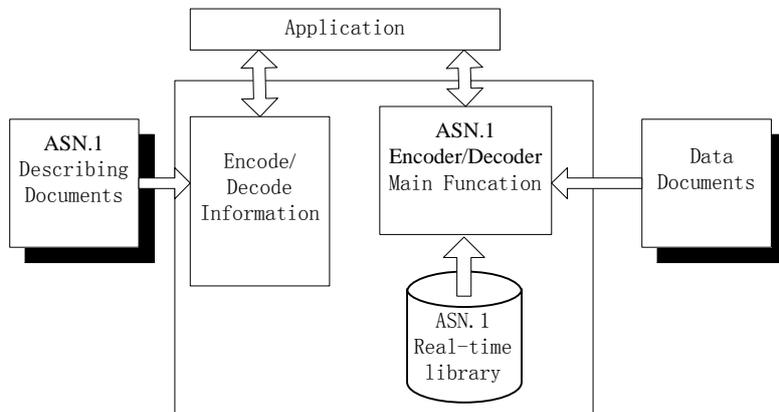
Fig.1. the flow chart of the ASN.1 Encoder/Decoder

(2) The transmission of RTP messages uses by the master scheduling mechanism.Bus master releases main frame to poll dispatch communication. When multiple devices respond to the message data request ,it will collide and then the bus master starts arbitration mechanism. This recursive algorithm is choosen to realize arbitration address and to complete the multi-device response. Figure 2 below shows for the arbitration process under device address [2].
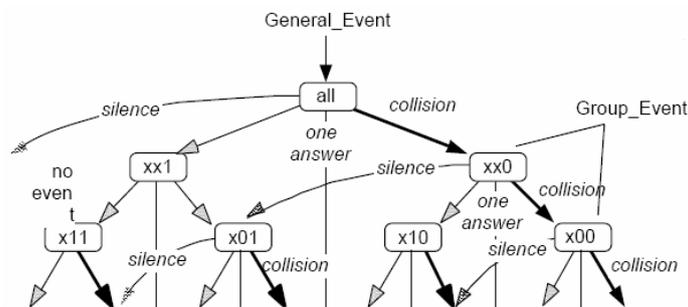

Fig.2. Event Arbitration

3.Study on network performances

In the course of train control equipment, communications and news service in real-time agreements are more important. Though studing the Transport Layer message data , write message data layer protocol design,simulate in NS2 (Network Simulator, version2), build a virtual network environment to simulate the configuration of this agreement to make the nodes more freely communicate, and test efficiency of communication, research influencing factors of the communications efficiency .Figure 3 shows for the frame work of tesing bed based on NS2.
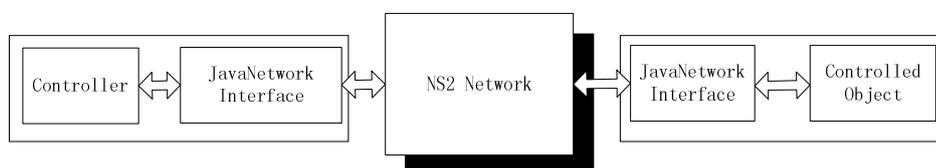

Fig.3 the framework of testing bed based on NS2

This paper studies the following two elements.
（1）According to contents of the TCN RTP, design news transport layer protocol by using C + +; use NS2 to build a virtual environment TCN network topology, and add the preparation of the agreement to a virtual network node,test communication of the nodes by using the protocol.
（2）Test the running performance of agreement to run. Awk software is used to analyze data on the node, including loss rate of the message data packet, delay and jitter rate, and test the effectiveness of network operations.Comparative analysis is not clearly defined in TCN real-time protocol, including the initiative problem of implicit solution.

4.Train control equipment configuration function design

TCCL(the Train Control_equirement's Configuration Language) ,on one side, which can describe the basic functions of train control equipment and can access basic information for device plug and play, is the premise equipment interoperability; on the other side , through the configuration file ,can configure the basic functions of train control equipment and set equipment operating parameters to achieve device configuration.

4.1 Configuration options

TCCL file uses XML markup language and the object model involves three levels. The first-level is related with train control systems, describes device capabilities, network

topology and the key data format, indicates parameter characteristics of the train control system device.The second level is related with train control equipment.The third related the object by the communication model. Implementing Configurator in TCCL XML parser has the following two common methods [5].

（1）Using Microsoft's msxml4.dll components. There are usually two ways parsing XML documents. One is the DOM (Document Object Model) ,another method is SAX (Simple API for XML) approach.

（2）Using JDOM based on JAVA language. JDOM is a open-source project, which is based on tree structure, using pure JAVA technology implementation on the XML document analysis, formation, and a variety of serialization operation. JDOM services directly JAVA programming.

In view of openness and portability features, the research chooses Configurator JDOM as analytical tool.

4.2 Configuration feature

According to the requirements of TCN, the paper design flow chart of train control communications equipment configurator show in Figure 4. In accordance with the above analysis, train control equipment configuration features are included in the following parts [6].

(1) Type information into train control equipment, documents, check whether the configurator database with the corresponding device type information, and if not, suggest new types information into devices; If already have, then prompte whether the need compare between new and old files after import, or directly covering .

(2) TCCL Configurator import information file ,then first verify the legitimacy of the file. Verify the legality including three main elements.First, XML syntax validation, whether the XML file configuration accord to file format. Second ,TCCL syntax verification, testing whether the configuration information file TCN given specifications; third,verify the device type, testing configuration information file if they meet specified type of device capabilities. If the detect is inconsistent with some of the actual situation,then give warning.

（3）Configurator pre-generate configuration information of a particular type of train control device according to device type information files, parse input information stratification into the corresponding information object according to the information model.In the configuration, each object is available separately edited by the configuration which check the necessary restrictions; configurator can create the configuration information file of entirety train control devices according to all the configuration information of each train control device, and can be exported as needed.

TCN configuration tool parses the input configuration information into the corresponding information object based on TCN information model, then reflect in the configuration interface; which edits each object and realizes a wide variety response constraints.The final configuration complete and then export TCCL file.
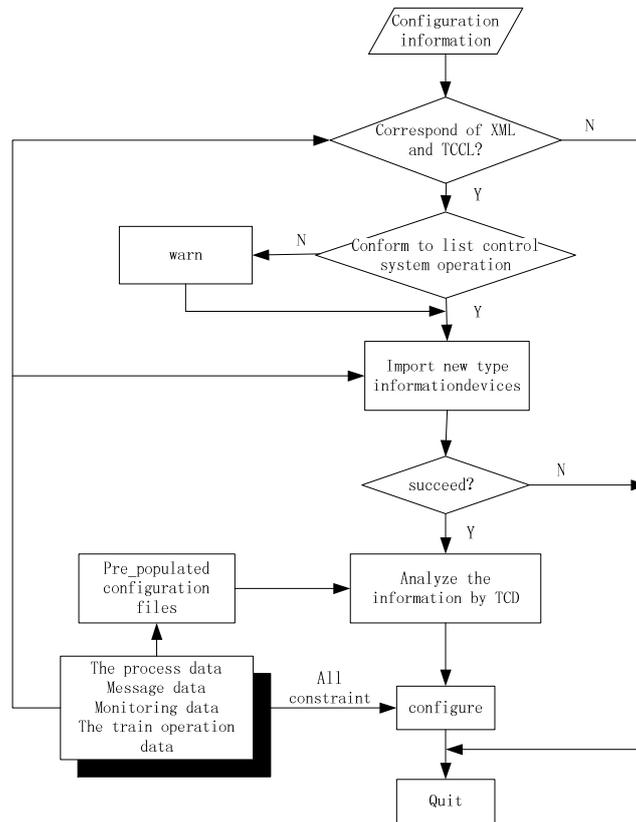
Fig.4. Flow chart of configurator operation

5. Conclusion

With the rapid development of high-speed railway in China, TCN in the electric multiple unit (EMU) also be applied gradually, train network control systems network architecture of China's CRH1, CRH3 developed and manufactured use the TCN standard.The widely using of TCN offers localization process of train control system a broad market prospect. At the first of the paper, design configuration files of the train control system; then ,establish communication characteristics of the object model according TCN RTP, using the NS2

construct test TCN network environment; finally ,complete communications network transmission verification.

Acknowledgement

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