Research and Design of Communication based on Train Real-time Ethernet message data

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Abstract

In this paper, the Ethernet Train Backbone Node(ETBN) is taken as the key research object, the Train real-time data protocol message data(TRDP-MD)between ETBN and Ethernet consist network (ECN) equipment is simulated, the data exchange with ETBN is realized, and the TRDP communication packet capture analysis is carried out with Wireshark software. The realization of communication technology between ECN equipment and ETBN is verified. This paper provides the basis for the development and application of Ethernet train communication technology, the preliminary research design and experimental test, and provides the foundation for the next Ethernet train debugging and the software application development of system diagnosis.

Keywords

Ethernet train backbone node (ETBN), Train real-time data protocol message data (TRDP-MD) Ethernet consist network (ECN).

1. Introduction

The communication of real-time Ethernet in train operation will use many kinds of data, including process data, message data, monitor data, streaming media data and so on. The process data is transmitted periodically. It can reflect the running state of the train in real time. TRDP is applied to process data transmission. The design of communication framework and corresponding software based on TRDP is established, and carries on the data to packet capture analysis research.

2. Basic Network Architecture

The Ethernet train network architecture is as follows: Train grade: ETB (Ethernet train backbone) Vehicle grade: ECN. ETB can connect to the composition network located in different groups through ETBN, each component network can connect terminal equipment[1].Ethernet train development and application have the following characteristics: Real-time Ethernet train will support almost all existing train bus technologies and have the characteristics of high transmission rate level and wide compatibility. In the future, the possibility of network conflict will be greatly reduced in train communication network. The real-time performance of train network communication data transmission will obviously increase with the development of the existing technology of Ethernet, and the market cost will increase. The future Ethernet train bus will have more obvious price advantages, and its popularization will be more convenient. The specific architecture is shown in figure 1:

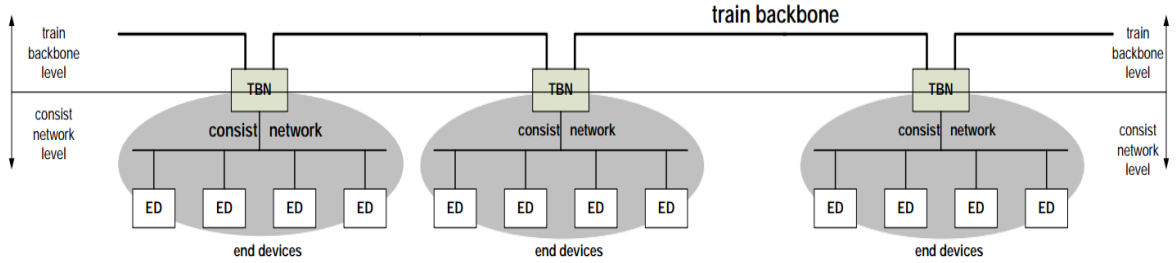

Fig.1 Train backbone consist network

3. Transmission Mode of message data

TRDP is used to ensure the integrity and real-time performance of network communication, including storage, transmission / reception, optional sorting, and the formation of traffic [2]. For the exchange of TCN process data or message data on ETB, the execution of TRDP is at the bottom of TRDP / UDP. All TRDP data on the bus is defined as a start and byte queue. Before ordering TRDP service primitives to send data, the application layer will have an explicit service primitive to arrange the sorting of user data.

The TRDP Train Real-time data Protocol defines two main communication modes: TRDP-PD (process data) and TRDP-MD (message data). Together, they constitute the communication main body of Ethernet Train Communication Network [3]. TRDP-MD is an aperiodic communication mode. Its communication is based on the requirements of Ethernet train users or equipment. It can be called accidental data. TRDP-MD is called accidental data because of its irregular transmission. When UDP is used for transmission, its data set ranges from 0-64k bytes to 4G bytes by TCP transmission [4].

4. Design of Communication Software

Running the software on PC, communicating with the ETBN based on TRDP and exchanging data is the most important equipment of Ethernet train. When it can communicate with the ETBN of the train, this means that communication with any equipment of Ethernet train.

4.1 Design of Communication between simulated ECN equipment and ETBN

The ETBN will automatically allocate IP to 10.0.0.1 on the ECN side, set the source IP to 10.0.0.5, and the destination address to 10.0.0.1.

The next step is to program functions. First call the function (tlc init()) to initialize TRDP stack. TRDP-MD transmission may call TC transmission or UDP transmission according to the user's demand. It then adopts:

(1) strncpy(opts.srcuri, "message.hmi", sizeof(opts.srcuri));

(2) strncpy(opts.dsturi, "message.etbn", sizeof(opts.dsturi));

The two sides of message data communication can be called Caller and Replier respectively. In order to obtain the information of ETBN, the PC is set to Caller mode. Then the basic parameter configuration of TRDP-MD communication is carried out. Set its send priority to 3 and packet lifetime TTL to 64.The TRDP-MD communication flag is set to (TRDP_FLAGS_CALLBACK | TRDP _FLAGS_TCP), set the confirmation, connection, and reply timeout of TRDP-MD communication respectively. Then set the message data communication port at 20550.After the most basic configuration of the communication parameter is done, the call the function (tlc_openSession())opens the session and returns a handle for TRDP-MD communication.

A request message with a specific ComID value of 108 will be configured for the ETBN below. Set the ComID = 108 message source and destination URIs and the data message identifier as (TRDP_MSG_MR).

Set the destination IP of the transmission to ETBN. Then the expected response number of the request message on the Caller side is set to 1, which means that the receiving side of the request message, ETBN, which wants to receive the request message as the Replier party for message data communication, can receive and process the correct request received.The ETBN will reply to a ComID = 109 message. The message will contain the train network directory information stored in the ETBN after the train is first running. After completing the above configuration settings, the program enters the main loop.

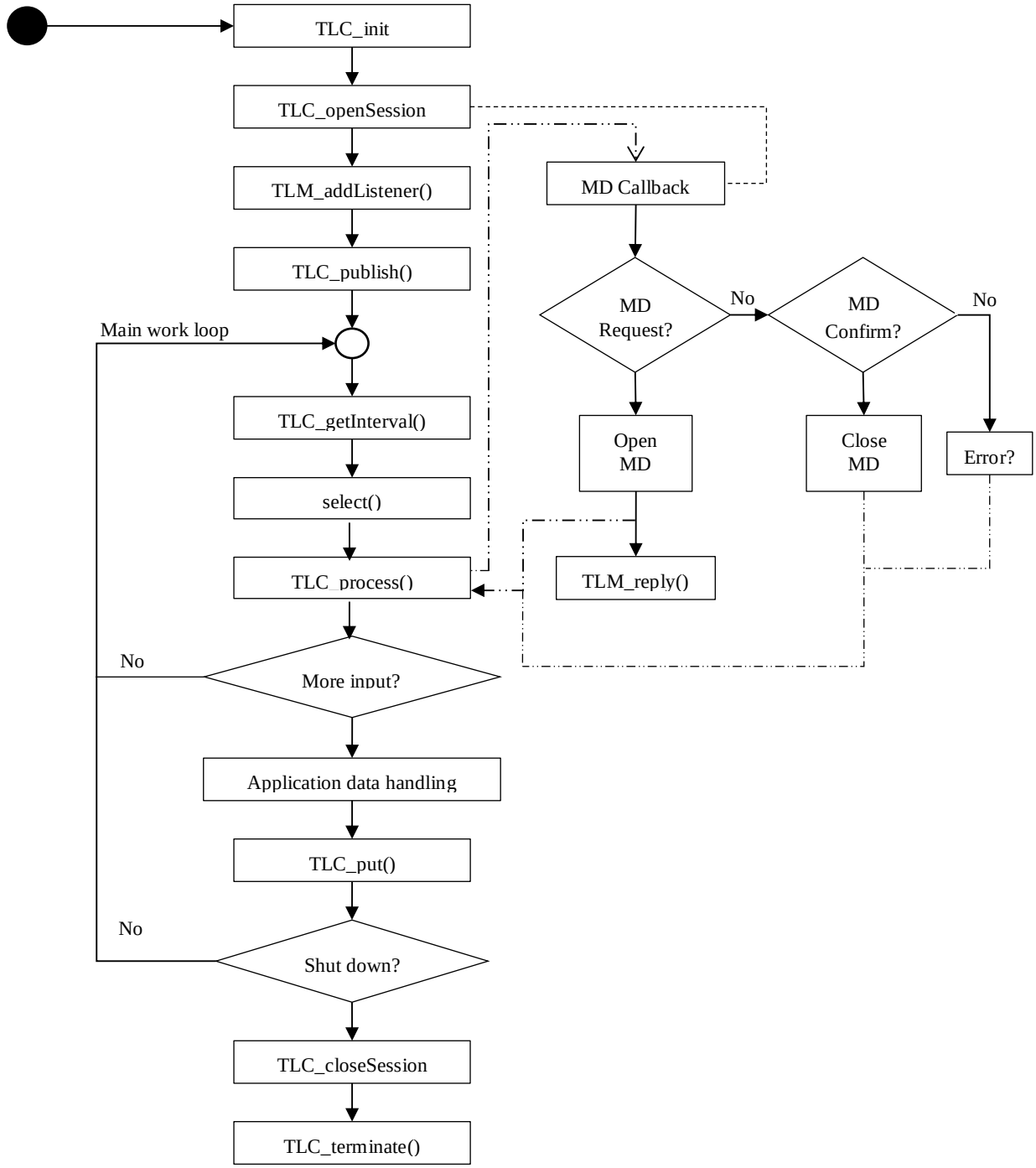

Fig. 2 Single Thread MD Callback Workflow

4.2 Design and implementation of TRDP-MD receiving Program

For the receiver design function (recv_msg()) to realize the TRDP-MD message reception.Within this function, the decision is made based on the message data type.

First, an output print is set to display the received message directly.When the number of responses is set to 1, if the received message is a request message, the reply function is selected based on the

received ComID value. The request message received by the reply is implemented using the (reply ()) function, and the destination address of the reply needs to be set. It is recognized that the port of TRDP-MD has a confirmation when receiving the reply message.

For the received reply message, will focus on the study. Because the request message of ComID = 108 is designed, and the ETBN will return a reply message of ComID = 109. When the reply message is received, it will judge its type as MP, and select the received message with ComID = 109 according to (msg- > ComID). An empty structure object is defined according to the operating train directory structure, and then the received data is selected bit by bit and assigned to the object. Then call the function (printf) to implement the print display of the received data, as follows:

printf(" cstUUI=%s opCstNo=%d \n", trdpOpTrainDirT.opCstList[i].trnCstNo);

5. Construct Communication platform

In order to verify the above design, we must build a real-time Ethernet train network communication test platform based on TRDP protocol.

First, the most basic TRDP-MD message data communication simulation test.

On the basis of this, the design and development are carried out again, so that the software can realize the communication between the simulated ECN equipment and the ETBN.

5.1 Software Foundation of TRDP Communication experiment platform

5.1.1 Integrated development environment UniCAP

UniCAP. can be used for configuration and application development of VCU、 HMI、RIOM. It is used to display distributed control system according to the connection relationship between topology and components. Some program components form the application. UniCAP provides a FBD library, providing a large number of common function blocks.

5.1.2 Wireshark configuration

Wireshark is a network packet analysis software. Carefully analyzing the data message captured by Wireshark can truly reflect the communication process of Ethernet train.

Workflow:(1) You need to determine the right position of Wireshark.(2) Select the capture interface. Select the Ethernet interface of train equipment to capture TRDP communication-related packets.(3) Use a capture filter. By setting the "TRDP-MD" filter condition directly at the filter port, we can avoid producing larger capture files, which ensures that other data are not interfered with when analyzing the captured data flow.(4) Use coloring rules. During communication testing, we can use coloring display filter to filter the requirement data when normal TRDP communication test is in progress.

5.2 Construction of TRDP Communication experiment platform

At this time, the software design is written in C language, so the running platform of the software will also be carried out on PC. For the programming software which can run on PC, it will have great portability, and can provide a good foundation for the future cross-platform use, and continue to expand and add functions. The communication between PC and train ETBN is realized by Ethernet connection.

5.3 Verification of TRDP-MD Communication between PC and ETBN

PC:PC(10.0.0.5) - REQUEST(ComID= 108)→ETBN(10.0.0.1).

ETBN:ETBN(10.0.0.1) - REPLY(ComID = 109)→PC(10.0.0.5).

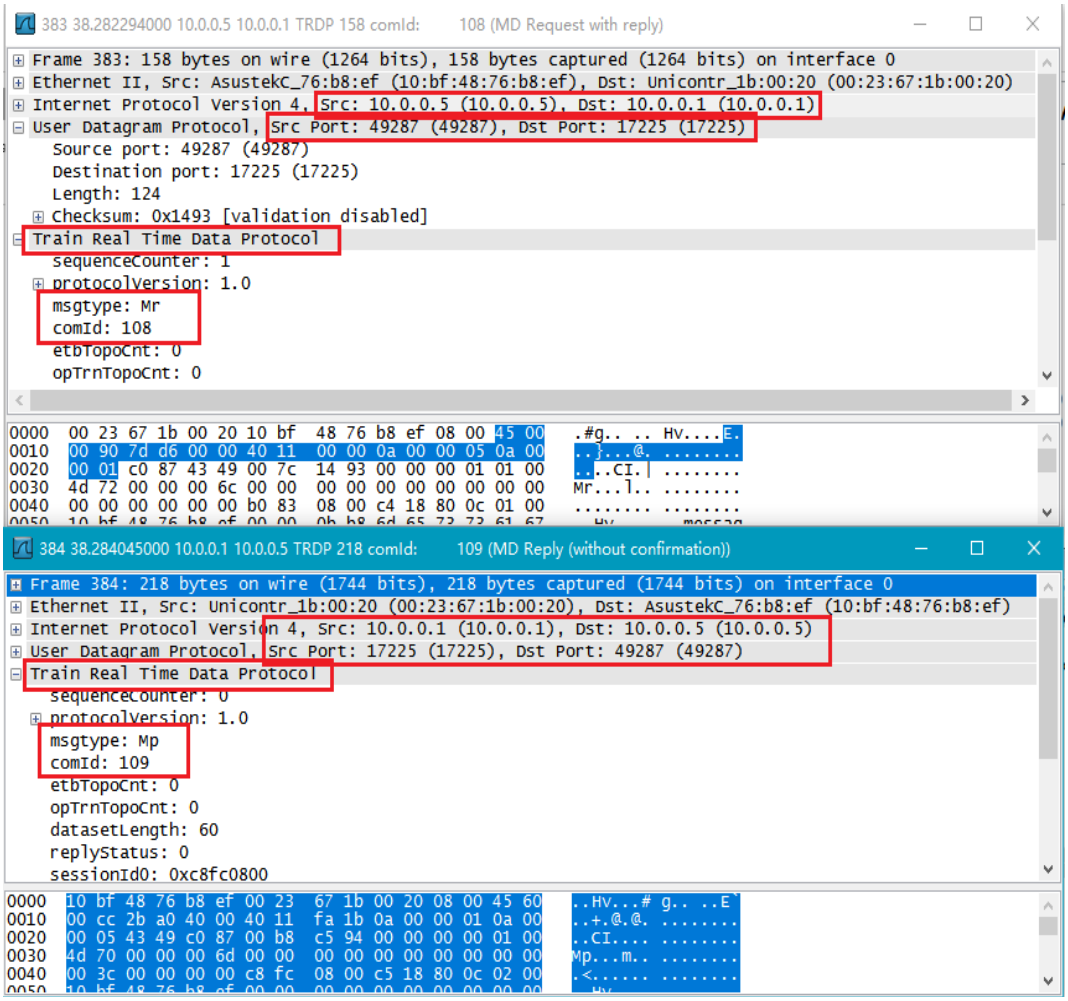

Fig. 3 ComID=108 && ComID=109 telegram analysis

PC:PC(10.0.0.5) - REQUEST(ComID=130)→ETBN(10.0.0.1).

ETBN:ETBN(10.0.0.1) - REPLY(ComID=131)→PC(10.0.0.5).

Through the communication between TRDP-MD (request-reply) ComID = 108/109 and ComID = 130/131 between PC (10.0.0.5) and ETBN (10.0.0.1), it is verified that the program can send and receive TRDP-MD correctly with ETBN .Packet capture and message as shown in figure 4.

6. Conclusion

In conclusion , as the development direction of the next generation train bus , the Ethernet train backbone has very important research value and research requirements for the communication technology of the Ethernet train ECN equipment and ETBN. Based on the communication programming implementation of the train ECN equipment and ETBN communication technology , this paper can provide a reliable application foundation for the next step of the Ethernet train diagnosis and the development design of the network application test software , so the research has great practical needs and important practical significance .

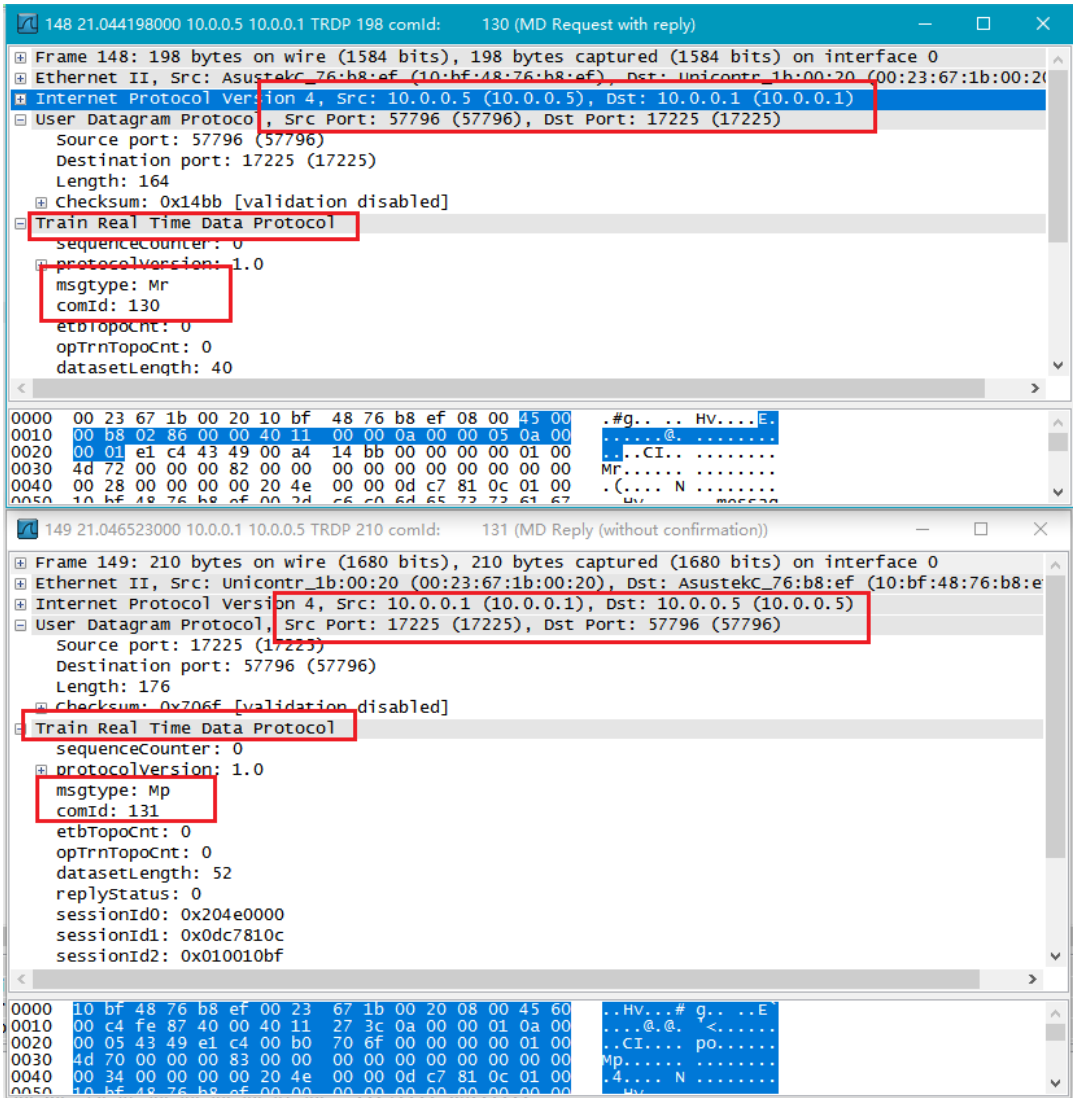

Fig.4 ComID=130 && ComID=131 telegram analysis

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