Design and Modeling of AADL in Communication Based Train Control System

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Abstract. Due to the hugeness and complexity of Communication Based Train Control system, the system can be split into four subsystems and defines the interfaces between the subsystems by analyzing the characteristics of the system's functions. Using the Architecture Analysis and Design Language gives the design and modeling of each subsystem with OSATE tools. According to the specific needs of the railroad system, the modeling of each subsystem uses the reasonable AADL components.

Keywords: AADL Railroad system Train control system component OSATE

1 Introduction

In September 1999, IEEE defined that a CBTC system is a continuous, automatic train control system utilizing high-resolution train location determination, independent of track circuits; continuous, high-capacity, bidirectional train-to-wayside data communications; and train-borne and wayside processors capable of implementing automatic train protection functions, as well as optional automatic train operation and automatic train supervision functions [1,10,11].

Component is the most important concept in AADL. The main components in AADL (Architecture Analysis and Design Language) are divided into three parts: software components, hardware components and composite components [2,3,4,5,6].This paper closes by highlighting the use of the AADL and its tools in the modeling of CBTC system. In this paper, we mainly use OSATE tools .

2 Design and Modeling of CBTC

According to the characteristics of the CBTC system's functions, generally, the system can be effectively split into four subsystems:

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automatic train supervision (ATS) subsystem, zone control subsystem, vehicle on-board subsystem and data communication subsystem.

In OSATE environment, we will use the AADL to give the design and modeling of the CBTC system. The CBTC system's file structure is shown in Figure 1.

As can be seen from Figure 1, the CBTC system contains four subsystems; data communication subsystem is a bridge of communication between the other three subsystems. OSATE will automatically generate an aaxl file for each aadl file; we can take advantage of aaxl file to new a corresponding graphics file (aaxldi file). The file lists the graphical representation of all components. And each implementation of the system components will generate a system instance diagram. The system instance diagram of the CBTC system implementation (CBTCSystem.Impl) is shown in Figure 2.

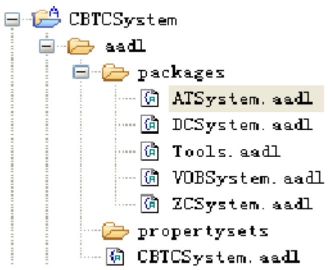


Fig. 1. CBTC system's file structure

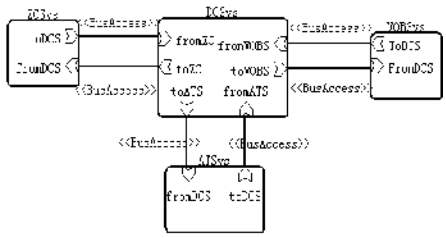
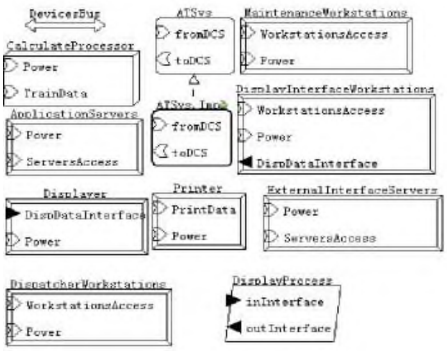


Fig. 2. system instance diagram of the of CBTC system implementation

2.1 Design and Modeling of ATS Subsystem

The main parts of ATS subsystem are as follows: application server, external interface servers, large screen interface workstation, maintenance workstation, dispatcher workstations (director workstations, dispatcher workstations and station workstations), printers, large-screen display and other equipments.

All of the components in the ATS subsystem are shown in Figure 3. And the system instance diagram of ATS subsystem implementation (ATSys.Impl) is shown in Figure 4. The fromDCS is the interface from data communication subsystem to the ATS subsystem, and the toDCS is the interface from the ATS subsystem to the data communication subsystem.



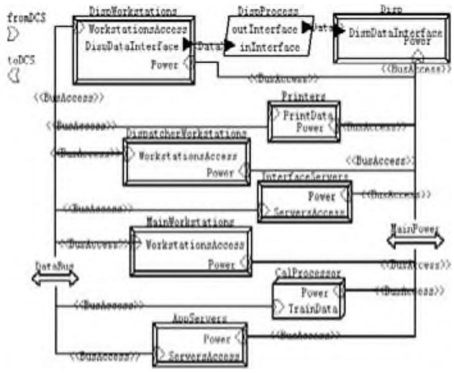


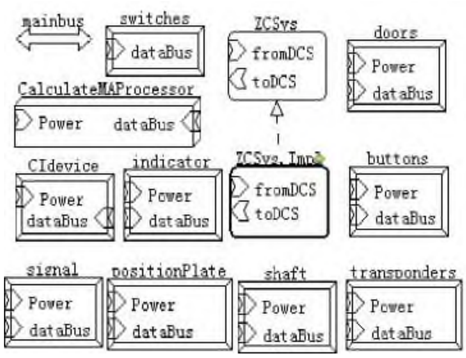
Fig. 3. the components in the ATS subsystem

Fig. 4. system instance diagram of the of ATS subsystem implementation

2.2 Design and Modeling of Zone Control Subsystem

Zone control subsystem[7,8] includes zone controller (ZC), the computer interlocking (CI) devices, axle counting equipments, signals, platform doors, switches, platform emergency stopping button, position plate, balises, train departure indicator and a series of wayside equipments.

The components used in the subsystem are shown in Figure 5. And in the system instance diagram of zone control subsystem implementation (ZCSys.Impl), the mainBus , also named ZCBus,connects to the dataBus features of all components and the MainPower connects to the Power features of all components.



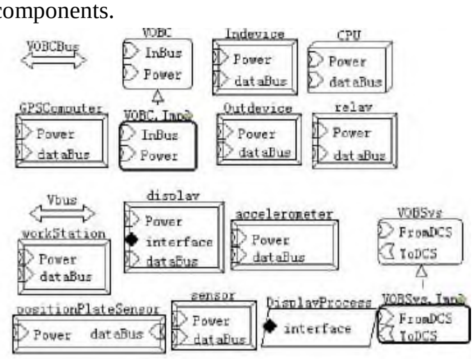


Fig.5.components used in the zone control subsystem

Fig. 6. components used in the vehicle on-board subsystem

2.3 Design and Modeling of Vehicle On-board Subsystem

The vehicle on-board subsystem includes the vehicle on-board controller (VOBC) and its peripheral devices. The VOBC contains the electronic unit (EU), the interface relay unit (IRU), power supply unit and other components. The EU includes a high-frequency receiver / transmitter, data receiver / transmitter, receiving / transmitting cards, CPU, GPS computers and other equipments. The IRU contains relay panel, interconnect cables between EU and IRU. The peripheral devices of the VOBC include speed sensor, accelerometer, the driver console, the driver display and position plate sensor.

The components used in the subsystem are shown in Figure 6.

The vehicle on-board subsystem has two system implementations: the VOBC system implementation (VOBC.Impl) and vehicle on-board subsystem implementation (VOBSys.Impl). In the VOBC system implementation, the VOBCBus , also named InnerBus,connects to the dataBus features of the components named Indevice, Gps, CPUnit, Outdevice and Relay. In the vehicle on-board subsystem implementation, the VBus, also named VMainBus, connects to the dataBus features of the other components and the port names interface of TODisplay connects to the port named interface of DisplayProcess.

2.4 Design and Modeling of Data Communication Subsystem

The data communication subsystem can provide the communication between the other subsystems. Any two indirect electronic devices connecting with data communication subsystem, can communicate with each other. The subsystem includes wireless access point (AP), the vehicle on-board wireless units, network switches, database storage unit and the backbone network.

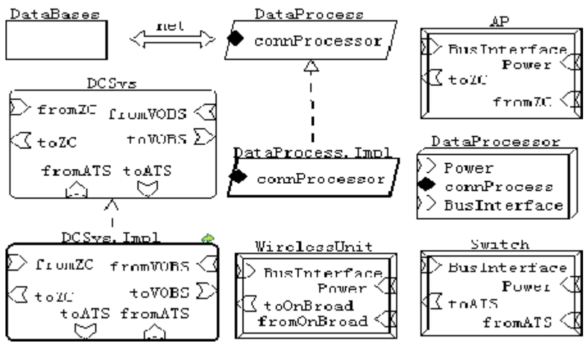


Fig. 7. components used in the data communication subsystem

The components used in the subsystem are shown in Figure 7.And in the system instance diagram of data communication subsystem implementation (DCSys.Impl), the bus net, also named NetAccess,connects to the BusInterface features of all components , the MainPower connects to the Power features of all components, and the connProcess of DataProcessor connects to the connProcessor of DataProcess.

3 Conclusion

In this paper, it is given a detailed analysis and design of the CBTC system, and the CBTC system is split into four subsystems,. At the same time, we use the AADL in each subsystem detailed analysis and modeling, and make an effective integration of all subsystems together to form a complete CBTC system. The entire system uses reasonable components to build model, but because of the time, this paper does not give the verification and analysis of system reliability and security, which will be the next focus of the study.

4 Acknowledgments

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